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July 10, 1961

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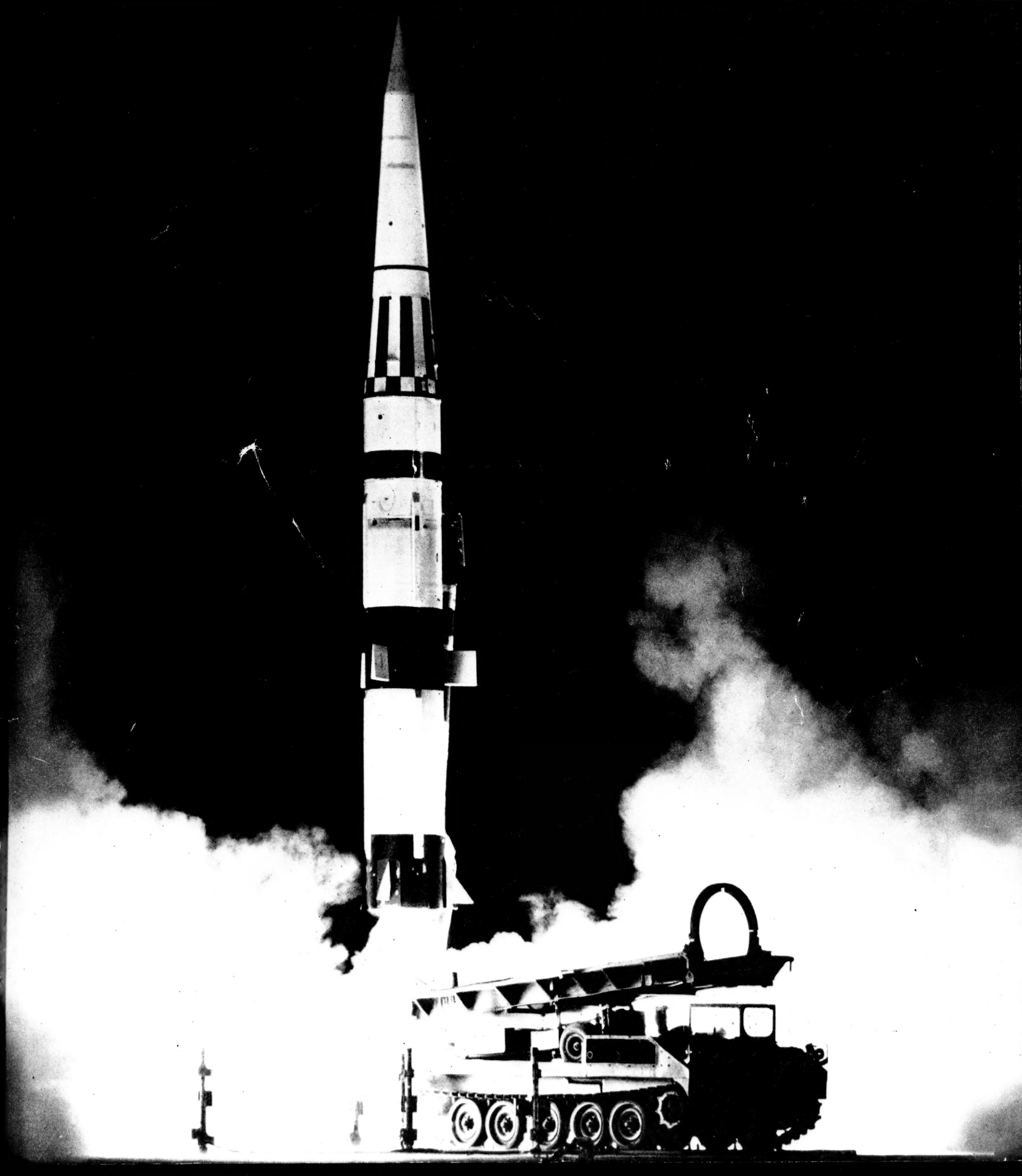

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AVIATION CALENDAR

July 17—Air Force Contract Aviation Services Symposium, National Aeronautical Services Assn., Hotel Washington, Washington, D. C.

July 19-21—Summer Meeting, Airlines Electronic Engineering Committee, Aeronautical Radio, Inc., Eden Roc Hotel, Miami Beach, Fla.

July 20-21—Quarterly Regional Meeting, Assn. of Local Transport Airlines, Grove Park Inn, Asheville, N. C.

July 22-24—Annual Meeting, American Assn. of Airport Executives' Northeast Chapter, Wilmington, Del.

July 24-26—Air Traffic Control Facilities Symposium, Electronic Maintenance Engineering Assn., Mayflower Hotel, Washington, D. C.

July 25-Aug. 10—International Trade Fair and Aviation Exhibition, McCormick Place Exposition Center, Chicago, Ill.

July 26-28—Annual Convention, Southeastern Aviation Trades Assn., Deauville Hotel, Miami, Fla.

July 31-Aug. 11—Conference on Physics of the Solar System and Re-entry Dynamics. For information write: Conference Director, Room 310, Holden Hall, Virginia Polytechnic Institute, Blacksburg, Va.

Aug. 1-3—Fourth Western Regional Meeting, American Astronautical Society, Sheraton-Palace Hotel, San Francisco, Calif.

Aug. 1-10—28th Annual U. S. National Soaring Championships, Wichita, Kan.

Aug. 2-4—Summer Meeting on Aerospace Applications for Hydraulic Fluids Test Methods, American Society for Testing

(*Continued on page 6*)

AVIATION WEEK and Space Technology

July 10, 1961
Vol. 75, No. 2

Published weekly with an additional issue in December by McGraw-Hill Publishing Company, James H. McGraw (1860-1948), Founder. See panel below for directions regarding subscription or change of address. **Executive, Editorial, Circulation and Advertising Offices: McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y.** Printed at Albany N. Y. OFFICERS OF THE PUBLICATIONS DIVISION: Nelson L. Bond, President; Shelton Fisher. Wallace F. Traendly, Senior Vice Presidents; John R. Callaham, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator. OFFICERS OF THE CORPORATION: Donald C. McGraw, President; Joseph A. Gerardi, Hugh J. Kelly, Harry L. Waddell, Executive Vice Presidents; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary.

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Single copies 75¢. Subscription rates—United States and possessions, $7 one year. Canada $8 one year. All other countries, $20 one year.

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Second class postage paid at Albany 1, N. Y. Printed in U. S. A. Title registered in U. S. Patent Office.

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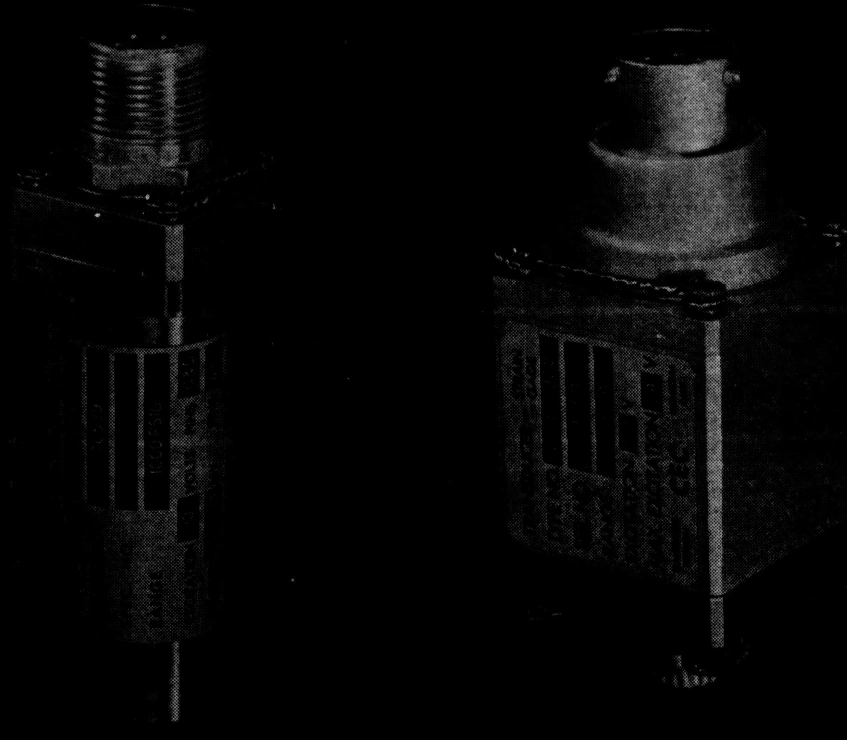

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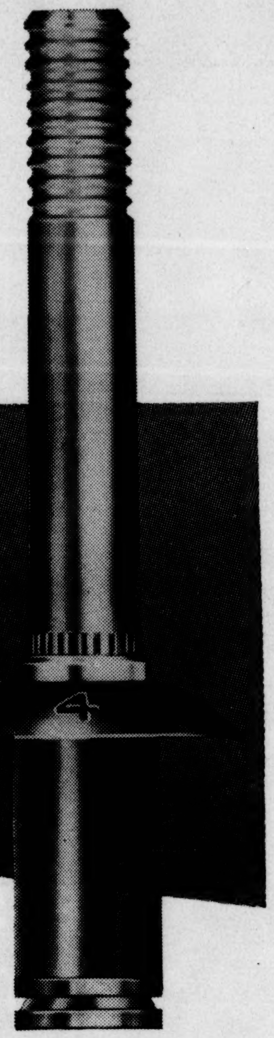

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AVIATION CALENDAR

(*Continued from page 5*)

Materials, Santa Ynez Inn, Pacific Palisades, Calif.

Aug. 3-6—North Central States' Airport Managers Conference, Mason City, Iowa.

Aug. 7-9—Guidance and Navigation Conference, American Rocket Society, Stanford University, Palo Alto, Calif.

Aug. 15-17—Cryogenic Engineering Conference, University of Michigan, Ann Arbor.

Aug. 16-18—International Hypersonics Conference, American Rocket Society, MIT, Cambridge, Mass.

Aug. 19-24—Institute of the Aerospace Sciences/Naval Aviation Meeting, San Diego, Calif. (Classified.)

Aug. 22-25—Western Electronic Show and Convention, Cow Palace, San Francisco.

Aug. 23-25—Fourth Biennial Gas Dynamics Symposium, American Rocket Society, Northwestern Technological Institute, Evanston, Ill.

Aug. 24-26—Sixth Annual National Reunion, OX5 Club of America, Allis Hotel, Wichita, Kan.

Aug. 30-Sept. 1—Third Annual Semiconductor Conference, American Institute of Mining, Metallurgical and Petroleum Engineers, Ambassador Hotel, Los Angeles.

Sept. 4-10—1961 Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.

Sept. 4-14—Eighth Anglo-American Aeronautical Conference, Royal Aeronautical Society and Institute of the Aerospace Sciences, London, England. Wilbur Wright Memorial Lecture, Sept. 12.

Sept. 6-8—National Symposium on Space Electronics and Telemetry, Institute of Radio Engineers, University of New Mexico, Albuquerque, N. M.

Sept. 10-12—National Convention, National Aeronautic Assn., Westbury, N. Y.

Sept. 13-14—International Operations and Maintenance Symposium, Airwork Corp., Millville, N. J.

Sept. 14-15—Ninth Annual Joint Societies Engineering-Management Conference, Institute of Radio Engineers, Hotel Roosevelt, New York, N. Y.

Sept. 15-17—Annual Convention, National Assn. of State Aviation Officials, Miami Beach, Fla.

Sept. 20-24—National Convention and Aerospace Panorama, Air Force Assn., Philadelphia, Pa.

Sept. 26-28—Annual Convention, National Business Aircraft Assn., Mayo Hotel, Tulsa, Okla.

Sept. 29-30—Society of Experimental Test Pilots' Fifth Annual Symposium (including a forum on the Supersonic Transport) and Awards Banquet, Beverly-Hilton Hotel, Beverly Hills, Calif.

Oct. 2-7—12th International Astronautical Congress, Washington, D. C.

Oct. 9-15—American Rocket Society's 16th Annual Meeting & Space Flight Report to the Nation, Coliseum, New York, N. Y.

Oct. 14-22—Federation Aeronautique Internationale 1961 General Conference, Hotel Quintandinha, Rio de Janeiro, Brazil.

Oct. 23-24—Joint Meeting, Canadian Aeronautical Institute/Institute of the Aerospace Sciences, Ottawa, Canada.

Oct. 23-27—17th Annual General Meeting, International Air Transport Assn., Sydney.

July 10, 1961

Aviation Week
and Space Technology

Vol. 75, No. 2
Member ABP and ABC

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COVER: Army-Martin Pershing battlefield support missile is fired at night at Cape Canaveral, Fla., from a transporter-erector-launcher mounted on an XM-474 tracked vehicle. The launch, made June 9, was the 17th in the Pershing flight test program and the fourth using the present missile configuration. The two-stage ballistic missile, which was not scheduled to go full range, landed "well within" accuracy requirement limits. Flares were ejected from the warhead unit to allow optical tracking during flight.

PICTURE CREDITS

Cover—U.S. Army; 25—UPI Radiotelephoto; 26—Aerojet-General (top left, bottom), Martin (top right); 27—U.S. Navy (top), Martin (bottom); 28, 61, 62, 63, 79—General Electric; 37—Fairchild Stratos Corp.; 50, 51—Douglas Aircraft; 54, 55—Herbert J. Coleman; 69—Hallicrafters; 71, 73—Dynisco Div. of American Brake Shoe Co.; 77—Aviation Week.

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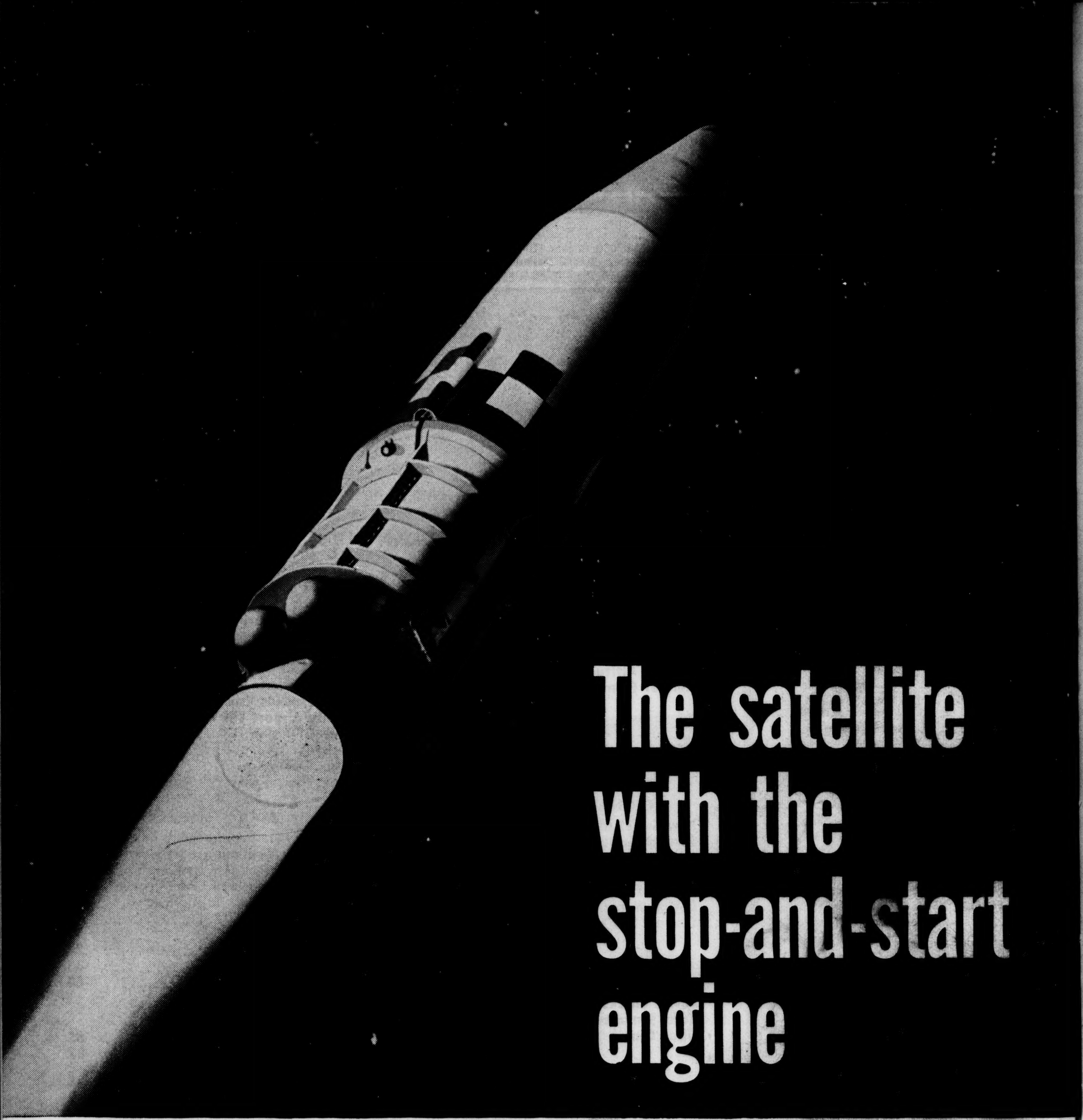
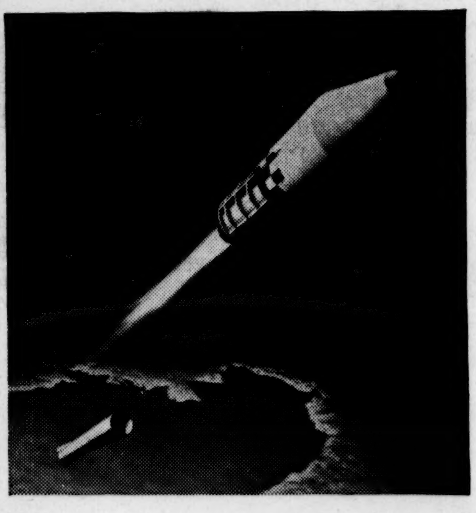
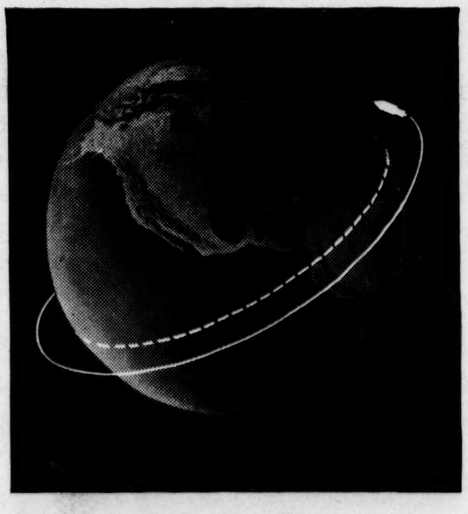




The Agena B's own engine ignites and drives it on to orbital velocity after first-stage booster burns out and drops away.



Radio signals from earth start and stop Agena B's engine to turn the original orbit into new around-the-equator orbit.

Why the Agena B gives America more orbits for the money

The Agena B's powerful rocket engine can be started and stopped at will by radio signals from earth. This new capability means 1) much greater certainty of reaching the desired orbit; 2) a heavier payload or a higher orbit from a given first-stage booster; 3) converting original orbits to around-the-equator orbits which hold great promise for communication and navigation satellites; 4) maintaining a satellite's precise position on orbit for long periods. Lockheed-built Agena Bs are now being used in the Discoverer, Midas, and Hawkeye programs of the U.S. Air Force, the Advent program of the U.S. Army, and the Ranger, OGO, OAO, and Nimbus programs of the National Aeronautics and Space Administration. Major subcontractors: General Electric, Bell Aerospace, Philco.

LOCKHEED

MISSILES & SPACE DIVISION, SUNNYVALE, CALIFORNIA

EDITORIAL

A Major Mistake

The United States made a major policy mistake in abandoning high priority for advanced manned aircraft development and accepting at face value Nikita Khrushchev's statement that the Russians are pursuing the same policy to concentrate on ballistic missiles. This has become evident during the rehearsals for the 1961 Tushino air show scheduled to be flown yesterday over Moscow. In the month-long rehearsals for this show, Western observers perched on the railroad embankment that borders the grassy Tushino field were able to identify three new supersonic bombers, two new Mach 2-plus fighters, a new jet seaplane, a flying crane helicopter and a convertiplane the size of a DC-4 transport.

They also were able to note that the Red Air Force has equipped all of its latest operational fighters, such as the all-weather versions of the supersonic Farmer and Mach 2 Fishbed, with airborne radar and infrared guided missiles and has modernized its big bomber fleet of Bears, Bisons and Badgers with air-to-ground missiles with ranges up to 300 mi., supersonic speeds and radar guidance.

Largest of the three new supersonic bombers is Bounder (AW Dec. 1, 1958, p. 27; July 3, p. 27), an extremely large aircraft of B-36 size. In its present configuration, Bounder has high subsonic cruise capability with supersonic dash performance in the target area. It is built to take advanced powerplants, such as nuclear heat sources, for its huge turbojet engines. The Bounder in its conventionally-powered versions is an intercontinental bomber posing a grave threat to the North American air defense system. In its nuclear-powered versions, it would be a multi-threat missile launcher, early warning center and ECM station.

Next down the scale comes a beautiful new design that mounts two large turbojets on each side of the vertical tail fin and utilizes an extremely thin delta wing. This Mach 2 bomber is larger than the Convair B-58 and also is in the heavy class with intercontinental range from refueling.

The third supersonic bomber, Blinder, is in the medium class and appears to be a highly advanced development of Yakovlev's earlier Backfin (AW Jan. 20, 1958, p. 38). It has shoulder-mounted twin jets with a sharply swept wing and looks as though it could nudge Mach 2 in top speed.

Whether there were further surprises in store for observers of the Tushino show was not yet apparent at this writing. But the appearance of these three supersonic bombers makes clear the folly of abandoning the F-108 fighter project, aimed at developing a long-range Mach 3 interceptor as part of the B-70 program, and of allowing the air defenses of North America to slide into obsolescence on the grounds that the Soviet manned bomber threat would never grow beyond the subsonic Bears and Bisons.

The Bear and Bison fleet is now a new and more powerful threat as a second wave follow-up behind the supersonic bombers, hurling their megaton missile loads onto targets from beyond the range of the Nike Hercules missile and against a thinly manned airborne defense of F-106 and F-101 fighters over-saturated by the first supersonic waves of attackers.

Even the elaborate DEW, mid-Canada and Pinetree lines and the SAGE system have not been modernized to handle supersonic bomber attacks. Plans to do so were scrapped several years ago by the same defense officials who killed the F-108 development, cut down the F-106 Mach 2 interceptor program and slashed the Bomarc B missile force.

The two new Mach 2-plus, long-range interceptors displayed during the Tushino rehearsals, plus the modernization of Fishbed, Fitter, Faceplate and Farmer fighters with infrared and radar-guided air-to-air missiles, indicate a vastly increased air defense capability against Strategic Air Command subsonic B-52 bombers and highlights the pitifully small number of supersonic B-58s now programed for the SAC fleet. It also shows that the slowdown of the B-70 development program was the sheerest stupidity.

These new developments also indicate that the Soviets are not relying entirely on ground-to-air missiles for their air defense. These missiles represent only the inner defense core. The long-range interceptors equipped with airborne radar, guided missiles and Mach 2-plus speed to hunt their quarry are the tougher outer layers on which the Soviets count for the significant attrition of attacking bombers.

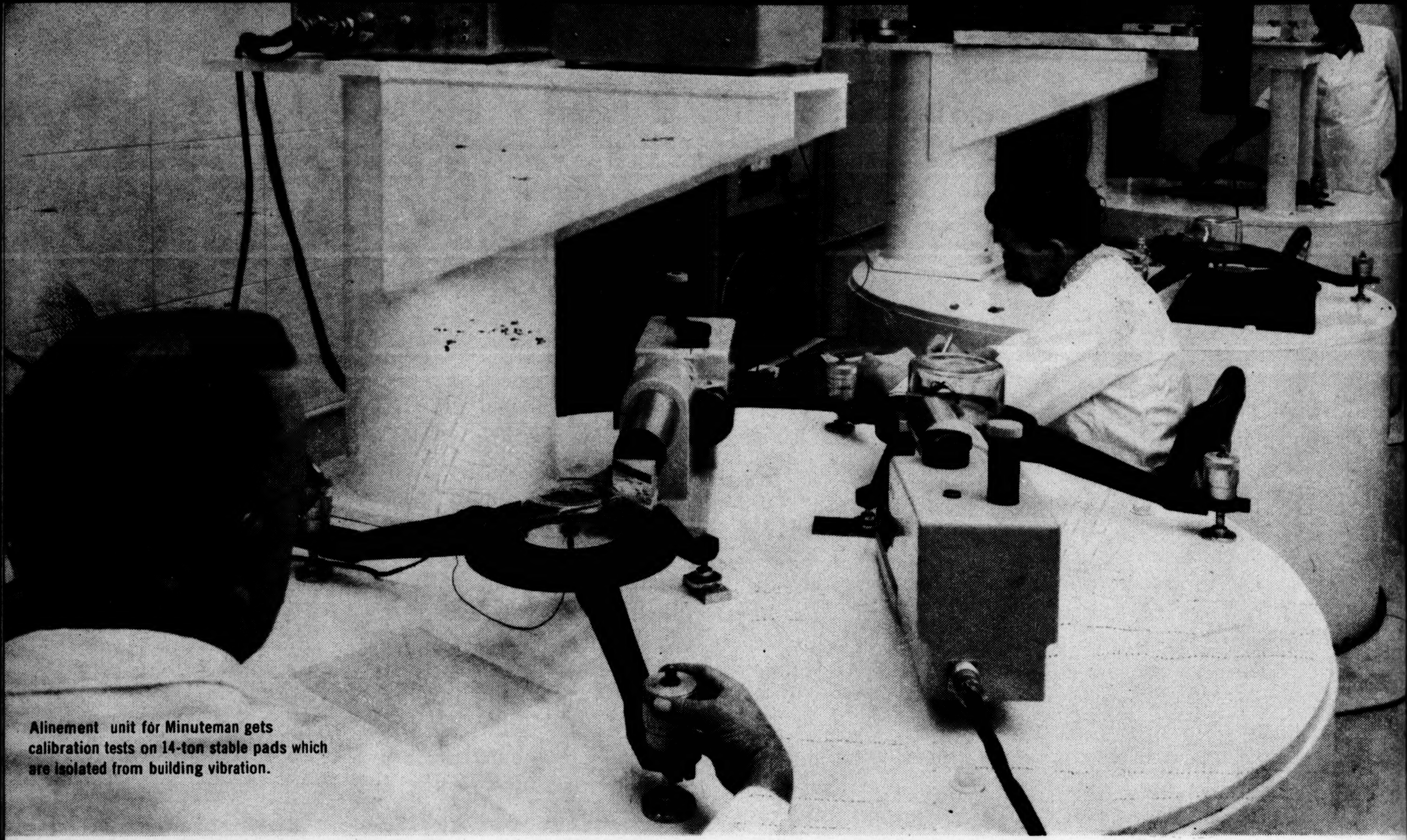
Both the family of supersonic bombers and this third generation of supersonic fighters indicate that the Soviet experience with ICBM reliability must be paralleling our own and that, despite Mr. Khrushchev's rocket rattling, they are still depending on the manned bomber as their first line of long-range offense. It also indicates they do not rate the effectiveness of our ICBM attack capability very high and are more worried about the delivery capability of the SAC bomber fleet.

The initial folly of curtailing advanced manned aircraft development occurred in the Eisenhower Administration in the face of official USAF warnings that this policy was foolhardy. But it has been enthusiastically endorsed by the Kennedy Administration in general and in particular by Robert McNamara, his Secretary of Defense.

Only in Congress, where the sage counsel of Representatives Carl Vinson and George Mahon and Senators Russell, Symington and Jackson prevailed, did the case for the continued development of manned bombers get a fair hearing. And we doubt whether these gentlemen of Congress, in the midst of passing on the Fiscal 1962 defense appropriation and authorization bills, were given much information on the ominous new birds that darkened Moscow skies in June.

We recommend that Congress and the American people demand the truth about the new Soviet airborne threat and that they earnestly inquire into why we made the incredible mistake of virtually abandoning advanced manned aircraft development to put all of our eggs in the ICBM basket long before this weapon reached operational reliability and technical maturity—and what our leaders propose to do about it now.

—Robert Hotz



Alinement unit for Minuteman gets calibration tests on 14-ton stable pads which are isolated from building vibration.

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***MINUTEMAN**

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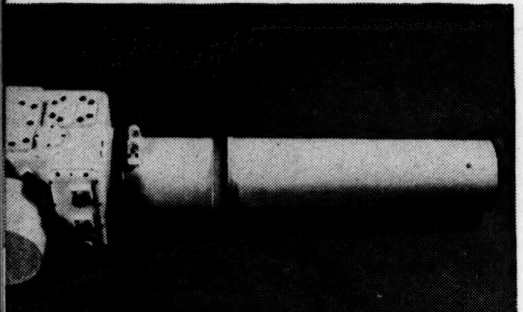
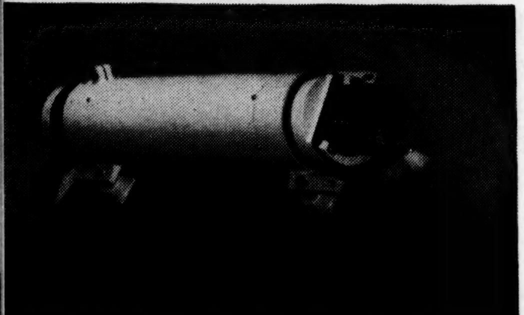


***NIKE-ZEUS**

Optical assembly for Bell Telephone Laboratories. For check of Nike Zeus radar alignment, the tracking system in which this assembly is used has a dynamic accuracy of better than 4 seconds of arc . . . can be adapted to operate in any part of the spectrum from the ultraviolet to the far infrared.



***POLARIS**

Optical deviator for Marine Equipment Department of Nortronics, a division of Northrop Corp. This electro-optical system checks the alignment of the navigation system of the Polaris bearing submarine. It deviates light 180 degrees and maintains accuracy of 2 seconds of arc even in severe vibration, shock and changing temperature environment.

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Gerald C. Schutz, vice president, Vitro Electronics, Silver Spring, Md., a division of Vitro Corp. of America.

Harvey P. Jolly, vice president-sales, United Aircraft International, East Hartford, Conn.

Everett Gravenhorst, vice president-sales and engineering, Arkwin Industries, Inc., Westbury, N. Y. Also: **George R. Hannes**, vice president-manufacturing; **Jack M. Brand**, contracts manager.

J. Gordon Bennett, assistant vice president for schedule development, American Airlines, Inc.

Moog Servocontrols, Inc., East Aurora, N. Y., has named the following as vice presidents: **Kenneth D. Garnjost**, corporate technical consultant; **Robert Z. Hague**, chief engineer; **Royal C. Kain**, general manager.

Fred W. Hottenroth, president, Gemco, Inc., Los Angeles, Calif., a subsidiary of Hupp Corp. Named vice presidents: **Jack J. Lane** for marketing; **Jerome Belsky** for manufacturing and engineering.

Roger H. B. Davis, comptroller, Servonics, Inc., Alexandria, Va., succeeding **Martin Brown**, resigned.

Fred M. Spuhler, assistant to the vice president and general sales manager of Trans World Airlines, Inc.

Maj. Gen. Daniel C. Doubleday, commander, Rome Air Development Center, Griffiss AFB, N. Y., replacing **Maj. Gen. D. P. Graul**, reassigned as deputy commander of the new Air Force Communications Service, Scott AFB, Ill.

Honors and Elections

H. M. Horner, chairman of United Aircraft Corp., has been elected chairman of the Board of Governors of the Aerospace Industries Assn. for 1961, and **Dan A. Kimball**, president of Aerojet-General Corp., was named vice chairman of the association. Elected to the Executive Committee of the Board: **Robert E. Gross**, chairman of Lockheed Aircraft Corp., and **Donald W. Douglas, Jr.**, president of Douglas Aircraft Co., Inc.

Changes

John A. Wotring, general service manager, Aero Hydraulics Division, Vickers, Inc., division of Sperry Rand Corp., Detroit, Mich.

Leo Botwin, assistant chief engineer, United Aircraft Corp.'s Norden Division, Norwalk, Conn.

L. F. Yost, Jr., manager-manufacturing, General Electric Co.'s Light Military Electronics Department, Utica, N. Y.

James P. Buckley, director-marketing and planning, Bendix-Pacific Division, The Bendix Corp., North Hollywood, Calif.

INDUSTRY OBSERVER

▶ Arpat darts, the interceptors that would be fired from the Arpat carrier vehicle to meet re-entering ICBM warheads (AW July 3, p. 29), are to be spheroidal or ellipsoidal in shape and may weigh less than 50 lb. They also might be equipped with special jets for velocity corrections in addition to their booster powerplants.

▶ **Navy and Coast Guard each will receive two Snap 7 series radioisotope auxiliary power generators, one producing 5 watts and another producing 30 watts. They will be used for such purposes as buoys, automatic weather stations and navigation facilities.**

▶ Scout 6 launch vehicle is currently scheduled to carry an S-56 payload identical to the S-55 micrometeoroid hazard satellite which failed to go into orbit. The test is not a backup but was planned as a repeat to continue micrometeoroid research. The S-56 is to be launched from Wallops Island, Va., within three months.

▶ **Only currently firm Air Force VTOL requirement is SOR-187, specifying a small search-retrieval aircraft to be carried by a C-130 class aircraft in a mother-daughter arrangement (AW Nov. 21, p. 23). Development plan was due out of Aeronautical Systems Division at the end of June.**

▶ National Aeronautics and Space Administration plans to build a static test facility at Marshall Space Flight Center for the Rocketdyne J-2 200,000-lb.-thrust liquid hydrogen/liquid oxygen rocket engine. Bechtel Corp. has a $32,000 design study contract to establish criteria for modification of the existing powerplant test stand to accommodate the J-2.

▶ **General Electric is trying to raise time between overhaul for the Convair B-58's J79-GE-5A turbojets to 1,000 hr. Current TBO for the General Electric J79-GE-7 afterburning engines in the Lockheed F-104C and D models is 500 hr.**

▶ Air Force is to take another look at its currently curtailed mobile Minuteman program in August. This redetermination was planned before the House Appropriations Committee expressed concern over the slowdown in this project.

▶ **West German research firm is working under Air Force contract on development of a lightweight paint for aircraft that would absorb radar signals, distorting or blocking their return to the receiver antenna.**

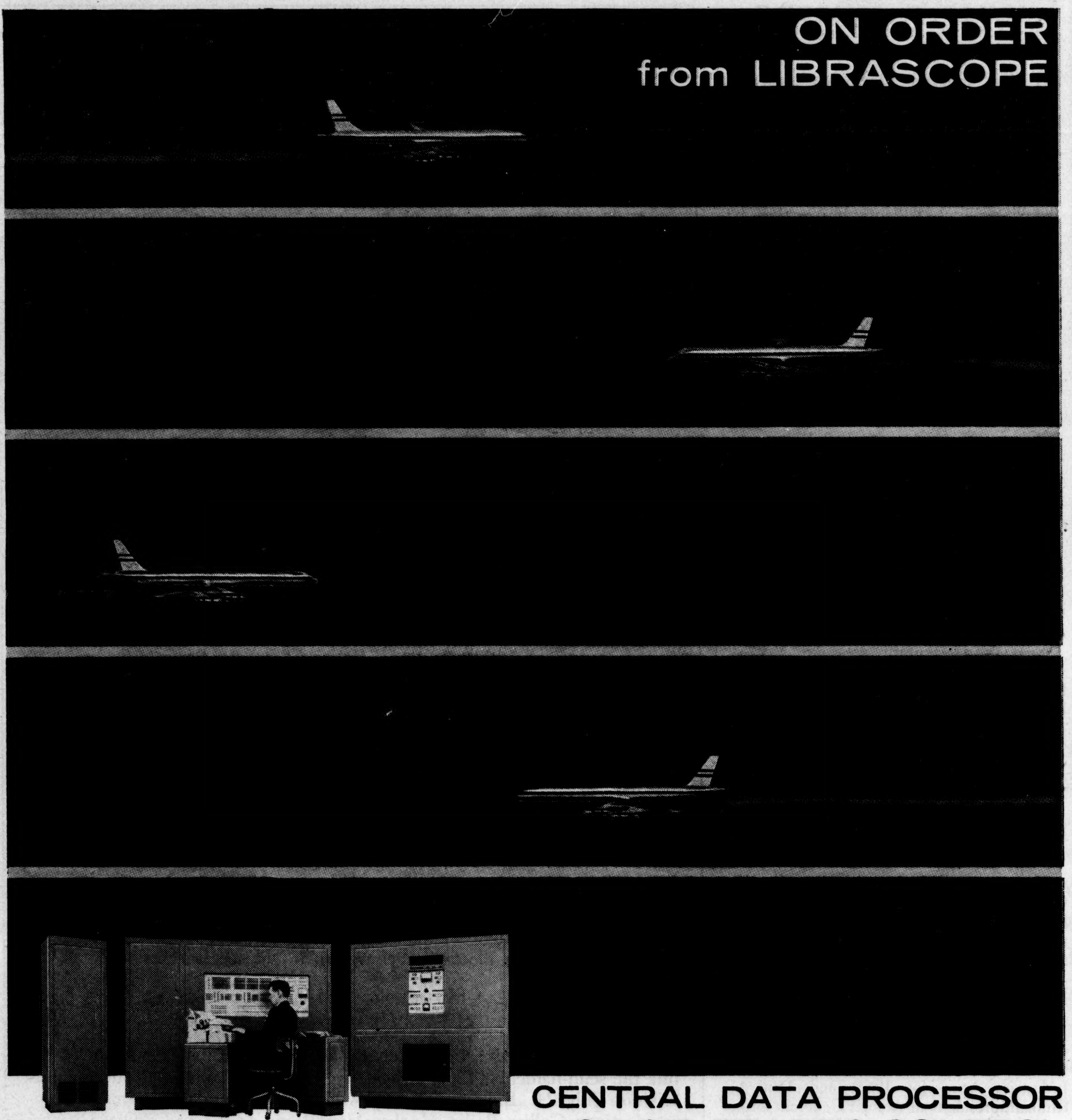
▶ Air Force has at least two advanced anti-ICBM research support projects under way—614A and 649D.

▶ **Proposals for the ultra high frequency communications system which is to link the semi-hardened Titan II bases are due at Air Force Ballistic Systems Division July 24. Bidders probably will include Melpar, Electronic Communications, Collins Radio, Hughes Aircraft and a team of General Dynamics Electronics and Motorola.**

▶ Aerospace Corp. is querying major solid propellant manufacturers on current capability for producing nozzles and cases for large boosters, as well as on their areas of propellant interests, methods of production and test facilities.

▶ **Douglas is proposing a second stage called Diana-A, using liquid hydrogen and liquid oxygen propellants, for a space booster being proposed to NASA and the Air Force. First stage would be a Thor IRBM with three Thiokol 50,000-lb.-thrust solid fuel rockets clustered around its base.**

▶ NASA is testing three blood pressure measurement devices for possible use in future Mercury capsule flights. Blood pressure was an important factor not measured during Cdr. Alan Shepard's MR-3 flight, but the agency hopes that a reliable sensor can be developed in time for the first manned orbital flight. Data probably will be recorded and stored in the capsule rather than being telemetered in flight.



CENTRAL DATA PROCESSOR for AIR TRAFFIC CONTROL

Today, at a peak traffic hour, approximately 200 aircraft flew over the New York area. Each year this number will increase. Yet, the Federal Aviation Agency will continue to assure safe and efficient control of air traffic. One reason . . . a data processor developed for the FAA by Librascope to quickly and accurately handle the routine clerical tasks now occupying most of the controller's time. The first 18-unit data processor will be installed at Boston in 1962. A note to Librascope outlining your control problems will bring a prompt answer from the country's most versatile manufacturer of computer control systems.

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Washington Roundup

NASA-Defense Study

Studies of the total national effort needed to provide facilities and support for the lunar landing program have been launched under an agreement between National Aeronautics and Space Administrator James Webb and Defense Secretary Robert S. McNamara. NASA now leans heavily on the military services for launching and tracking facilities, life sciences, and air and sea support and rescue forces. The agency will require even more help for the lunar effort.

Air Force studies begun by Maj. Gen. Leighton I. Davis, commander of the Air Force Missile Test Center, shortly after President Kennedy announced the lunar program have recommended great expansion of facilities there, including off-shore launching platforms to minimize noise and damage problems. One officer noted that this ambitious plan amounts to "moving the Florida peninsula three miles west from Cape Canaveral."

After the agreement was reached, Defense ordered studies made from a department-wide point of view, to include all services and their logistics systems. NASA studies are emphasizing impact on the national economy.

Rep. Emilio Q. Daddario, who has consistently favored use by NASA of existing military life sciences resources rather than expansion of NASA's own life sciences program, said last week the agency is using the lunar program as a cloak to ask for a $60-million manned space flight laboratory and increases of 100 people and $12.6 million for life sciences research. He urged that the military's capabilities not be wasted.

Political Tug-of-War

Both the manned flight laboratory and NASA's Space Task Group, which is managing Mercury and probably will direct Apollo spacecraft development, are the victims of a political tug-of-war. Rep. Albert Thomas, chairman of the appropriations subcommittee that passes on NASA's budget requests, has made no secret of his desire to have both located in his Texas district. Meanwhile, Rep. Thomas N. Downing is seeking 40,000 signatures from his Virginia constituents protesting transfer of STG from Langley Field. Despite Rep. Thomas' power, there are indications that he has lost the battle. But all NASA Administrator Webb will say is that no final plan has been approved.

Congress is growing increasingly reluctant to confer the kind of long-range authority for executive agencies that research efforts such as the 10-year space program require. Although the lawmakers recognize that complex technological projects cannot be successfully run on a year-to-year basis, they fear loss of congressional control over government.

This dilemma, now worrying many liberals as well as the conservatives who have long fought what they call "backdoor spending," forms the backdrop for public hearings on long-range federal programs which the Senate Government Operations subcommittee under Chairman Hubert Humphrey will hold July 18-19. Witnesses will include Defense Department Comptroller Charles J. Hitch and Dr. Harold Brown, director of defense research and engineering.

Ilyushins for Cubana

Cuba's state-operated airline, Compania Cubana de Aviacion, may become the first commercial operator of Soviet-built aircraft in the western hemisphere. It now is negotiating to buy replacements for Douglas DC-3s—probably Ilyushin Il-12 or Il-14 twin-piston engine transports. Cubana also is considering a Bristol Britannia cargo conversion that could haul freight between Havana and Prague or Moscow on a one-stop basis. Hard pressed for working capital, the airline is trying to sell three 800-series Vickers Viscounts to finance the purchases.

Russian delegation is expected to arrive in Washington this week to begin negotiations on a U.S.-USSR bilateral air agreement involving New York-Moscow service, including the controversial Soviet request for a route segment to Havana (AW Mar. 6, p. 41).

If the political situation dictates, Soviet Russia and Communist East Germany have a tool ready with which to try to halt U.S. air traffic into West Berlin. A law to take effect on Aug. 1 will require all aircraft with radios to receive special permission from East German authorities to cross their territory. This traffic now is handled by a four-nation air safety center.

Russia has renewed its protests over flights of the Lockheed U-2. Two Soviet officers, writing in the military journal Red Star, say the use of Alaska-based U-2s to check reconnaissance satellite equipment proves that "certain quarters in the U.S. cannot abandon the disgusting habit of looking through their neighbor's keyhole."

Canaveral Calamity

At the Atlantic Missile Range, where no one has been killed or seriously injured by the launching of a rocket in 11 yr. of operations, a 1.5 in. diameter, 10 in. long skyrocket followed an errant trajectory on July 4 and broke a window in the officers' club. Seven persons were injured, two seriously enough to require hospitalization.

—Washington Staff

European Space Program Speedup Asked

Space scientists of 12 Western European nations ask for comprehensive space plans within a few months.

By Herbert J. Coleman

London—European space scientists, determined to emerge from the shadow of the world's two great space powers, are bending their efforts to the development of a comprehensive program before the year's end.

Over-all feeling at the European Symposium on Space Technology here was that the 12 Western European nations must formulate cohesive space plans within a few months, or be content with minor projects of little broad scientific value.

Indicative of the European feelings toward establishment of programs separate from those of the U. S. and Russia was the unofficial backing of the de Havilland Blue Streak booster as a first-stage launcher, rather than using such U. S. missiles as the Convair Atlas or Chance-Vought Scout.

But although more than 200 scientists were registered for the symposium, there was not a single active participant representing a European political arm, with the exception of a British member of Parliament, David Price (AW July 3, p. 31).

In general, delegates agreed with a statement by A. V. Cleaver, chief engineer, rocket propulsion, Rolls-Royce, who declared: "The present time is critical. Unless we do get a program under way within months, we may never have one."

Cleaver was backed by G. K. C. Pardoe, of de Havilland, who stressed that "the root of all the troublesome delays and soul-searching is money, money, money."

Both men, of course, are deeply involved in development of Blue Streak, and they were asked both on and off the floor if Europe would not be in danger of duplicating U. S. space efforts—and vehicles—in the attempt to start a new program. As one delegate put it to Cleaver: "Won't Europe end up with a 12-stage booster through this space club?"

Cleaver replied that only through coordinated programs, using European scientists and ideas, could the program pay dividends for the 12-nation consortium "and these can be enormous." Pardoe added: "Using a European launcher is our means of getting our feet wet, providing laboratory facilities in space for our own use."

Germany now has agreed to support Blue Streak (see box p. 23), Britain and France have agreed to use the rocket as a first stage with the French Veronique as the second and a third stage still under consideration. British Space Development Co., headed by Sir Robert Renwick, has proposed to the West German government that public money be used to develop a communications satellite, but an answer has not yet been received.

U. S. government stayed well in the background during the London sessions. Lone representative was A. W. Frutkin, NASA's director, office of international programs, who promised cooperation in future programs similar to that now undertaken by his office. At one point, in a discussion of duplication of vehicles, Frutkin said the U. S. had and would remain silent "so as not to prejudice this matter."

Although Frutkin didn't say so, this may have been a direct result of a statement by Secretary of State Dean Rusk at a NATO meeting May 8 in Oslo, when he was reported to have privately offered Atlas, Thor or Scout as European space launchers. The report, never confirmed or denied, caused considerable rancor in Britain, which is deeply involved in Blue Streak, and in European countries protective of their national standings.

On the other hand, although it is seldom mentioned here, the U. S. has considerable technical and financial interest in Blue Streak. Both Rolls-Royce and de Havilland have complicated license agreements on the booster with Convair and Rocketdyne.

Question of sovereignty was ever-present, in view of the vast sums and impressive achievements by the U. S. and Russia. Said Cleaver: "If we in Western Europe have no program, the result is

Two-Stage Apollo Launch Vehicle Proposed

Two-stage launch vehicle consisting of Rocketdyne F-1 and J-2 engine clusters is being proposed by Martin Co. to boost the Apollo spacecraft on its lunar landing and return mission.

George S. Trimble, Jr., vice president for advanced programs, said that although Martin has concentrated on the Apollo spacecraft, the company proposes a booster stage of four F-1 engines surrounded by eight J-2s, which would provide a liftoff thrust of 7.6 million lb. Second stage would be eight J-2s, with a series of 300-lb. thrust verniers. Verniers could provide two mid-course thrust corrections of 10 sec. each.

All 12 booster engines would be ignited at launch, and the J-2s would be "controllable." Objective of this vehicle configuration would be to keep the number of stages to a minimum.

Martin's Apollo spacecraft, semi-ballistic in configuration, would have a re-entry range of 10,000 mi., sufficient to return to Edwards AFB, Calif., from most re-entry points.

Martin Co. was one of three which conducted funded Apollo feasibility studies for the National Aeronautics and Space Administration, which NASA is using to prepare specifications for the Apollo vehicle system. Bidders conference will be held July 18-20, and the agency is expected to request proposals in September.

Teams headed by Convair-Astronautics and General Electric also made feasibility studies on the project.

Highlights of the Martin Apollo spacecraft proposal included:

- **Escape weight would total about 140,000 lb., and the system would weigh 70,000 lb. when the lunar landing retrorocket was fired. Moon-launch weight would be 25,000 lb., re-entry package would weigh 7,000 lb., and the earth-landing vehicle would weigh 5,900 lb.**
- **Lunar landing would be initiated from a 50-mi. orbit by re-starting second-stage J-2s and using them as retrorockets. Single Pratt & Whitney LR-115 engine would be used for lunar launch.**
- **Earth launch trajectories have been computed to a tolerance of plus or minus one hour on any given day, using a polar escape route with components and heat shielding providing radiation protection. System is being designed for 100 REM radiation protection, and maximum expected in a solar flare is 67 REM.**
- **Guidance problem is one of the most severe, with current planning directed toward a self-contained inertial system.**

Trimble feels the manned lunar landing mission can be accomplished in 1966 if all systems are developed concurrently.

that 300 million people will be deprived of the future gains of space technology, thus retarding the entire field because our contributions would never be used . . . the consequences would be disastrous.

"It is not good enough to hitch a ride on U.S. or USSR research vehicles. There can be no scientific continuity if we rely on other powers; we must have a high degree of independence."

Warning against too much dependence on other powers, Cleaver used the Douglas Skybolt as an example. "We must face the facts of life," he said. "The United Kingdom has chosen Skybolt as a weapon, entirely dependent on the U. S. for its supply. . . . If the U. S. does not proceed with Skybolt, the United Kingdom is out. Independence with another large social unit means your policies are contingent on agreements with that country, agreements which can be broken or are not watertight."

Another loss to Western Europe, Cleaver contended, would be immigration of scientists to the U. S. in search of active research atmospheres. However, Frutkin interjected that when Blue Streak was dropped as a weapon, the U. S. declined overtures from a number of British scientists to relocate to the States on the grounds that such immigrations would drain the British talent pool.

Frutkin later told the delegates: "Some of us have taken a step or two; others have yet to do so. . . . With some judicious pulling and pushing, the forward progress of all may be facilitated."

NASA, Frutkin said, will maintain a broad program of cooperation in space with the Western nations.

Space Scientists

London—Today's space scientist must consider himself fortunate if he can allocate 10% of his time to pure research, according to Dr. Theodore von Karman, U. S. scientist who was opening chairman at the European Space Symposium here.

He illustrated his point this way: "If Isaac Newton were alive today, and the apple dropped on his nose, he first would conclude there was a force of gravitation worth some study.

"But then he would have to immediately report to his chairman of research and development who might say 'Newton, you are showing no imagination; this can apply to all fruits and we must consult with the British Fruit Growers Assn.' "

After long deliberation, Newton would get a research contract but only 10% of his time would have been devoted to the mathematics of the problem, and von Karman said: "This is the 10% we now aim at."

Pardoe, a scientist who has become a major British space spokesman, said European governments "must now surely realize that space will pay dividends—not intangible military dividends measured only in terms of human lives and national frontiers—but real, practical dividends." In initial programs, Pardoe leans toward weather and communications satellites as being of practical commercial use. Navigation satellites are another aspect European nations should explore, but predominantly, he continued, Europe must be highly selective in its future programs.

Asked from the floor why Europe could not arrange to have the U.S. launch a weather satellite on orbits best suited for the 12-nation consortium, Pardoe said: "Would the Americans provide ground stations, or relays, or analyzing means? We must look at this as an entire unit."

French point of view was aired by F. Vinsonneau, of SEREB (Societe d'Etude et de Realisation d'Engins Balistiques) who said French support Blue Streak as the basis of a heavy launcher, not "pretending that this is the only solution technically or economically possible. . . .

"What we did say, and repeat with conviction, was that once we believed that the only solution in the field was a United Europe, the experiences and methods gained by the United Kingdom formed a large part of our common fund of knowledge and it would be our duty to support them and to prevent their dispersal."

Duplication of efforts with the U.S., in Vinsonneau's view, "would be stupid," and Western nations should collaborate. First material proof of this, he said, would be in establishment of a large European laboratory devoted to space technology.

David Price, an economist besides being a member of the British Parliament, contended that the major domestic political issue of space research is in its eventual economic benefits. Because it is impossible at present to put a precise figure on, for instance, financial returns from a communications satellite, "space research is unlikely at present to appeal to the Finance Ministers of our countries," he said.

Price said he believed space benefits to be overwhelming "in the long run," but warned that "unfortunately, Ministers of Finance are not very interested 'in the long run,' if in the meantime we go bankrupt." This, he said, is the crux of the dilemma facing today's scientists.

A project somewhat less ambitious, but of immediate importance to space research was proposed by Henrich Faust, of Deutscher Wetterdienst (weather office) of West Germany. Faust called for establishment of a European meteorological rocket network for research coordinated with that at White Sands, Tonopah, Nev., Ft. Greeley and Ft. Churchill, Pt. Mugu, Wallops Island, Cape Canaveral and Eglin AFB.

Initial studies in Europe would probe wandering high and low pressure areas in the upper stratosphere and patterns of warming discovered in the lower stratosphere with high-altitude balloons.

Germans to Join Space Project

Bonn—West German Parliament, in a major step toward making the envisioned common European space program a reality, voted last week to join the project, accept its share of the financial burden and, more importantly, support use of a three-stage booster system based upon Britain's de Havilland Blue Streak as the first stage.

Blue Streak with an advanced version of the French Veronique research rocket as the second stage has been pushed firmly by Great Britain and France on both technical and political levels since early this year (AW Jan. 23, p. 34), with the Germans regarded as a possible major holdout. In some West German circles, at least, officials have supported adoption of an already-proven U. S. system, including versions of the Douglas Thor and the low-cost Chance Vought Scout.

Third stage of the European booster system, while still under discussion, probably will be a version of Britain's Black Knight. Production of the booster units and their components may be shared by member nations with manufacturing capabilities equal to the task.

Latest bid for adoption of a European space program centered around the Blue Streak-Veronique-Black Knight booster combination was made by the director of the United Kingdom Atomic Energy Authority's Research and Development Division at the European Symposium on Space Technology in London (AW July 3, p. 30).

In approving the plan, the West German Parliament also agreed to the proposed common financing plan for the European program in which Germany would shoulder approximately 18% of the cost. Great Britain, with 33%, would carry the greatest burden followed by France at 20%. The remainder would be shared by other European nations joining in the program. As outlined at the London symposium, total cost of such a program over a 10-year period would be about $140 million a year.

NASA Review Supports Atlas Despite Space Launch Failures

Washington—Formal review by the National Aeronautics and Space Administration indicates that despite its failures, there is nothing basically wrong with the Atlas as a space launch vehicle.

The Atlas, the key to successful manned orbital flight in Project Mercury, has been under a cloud because of failures in the space program (AW Jan. 23, p. 88). In 12 space missions using Atlas boosters, four have been successful, one partially successful, and seven have failed. Upper stages and components, rather than the Atlas system, account for most of the failures where the cause has been determined.

As a result of these failures, an all-NASA panel recently made a technical survey of the Atlas in the areas of structures, loads, materials and dynamics and concluded that the agency can choose among these alternatives in future use of the vehicle:

- **Strengthen the entire** airframe during production, making the vehicle heavier.
- **Limit missions** to optimum Atlas characteristics, and launch at optimum times with a standard vehicle.
- **Plan ahead for specific vehicles** to launch specific payloads, conduct integrated vehicle-payload dynamics analyses, and "custom-build" vehicles.

The panel favors the last alternative, since the first two would involve payload and mission penalties.

The implication that advance planning has been deficient stems from the Atlas space record. Of four Mercury flights, one was successful, two failed and one is considered a partial success. The three Able missions failed, and of four Agenas, two Samos and two Midas launches, only two were successes. The other success was Project Score. There have been 37 complete successes in 42 development flights of the Atlas D as a missile system.

NASA has ordered special modifications of the Atlas D for Mercury and is considering ordering them for orbiting astronomical observatory (OAO) payloads. The agency feels the Mercury capsule and the Atlas were made compatible with the installation of a steel stiffening band to strengthen the upper airframe (AW Jan. 16, p. 27). The rectangularly shaped OAO will be launched by a lengthened Atlas Agena B, and a special fairing will provide stability for the payload.

NASA is not considering changing boosters for Mercury because any change now would cause a serious delay—estimated at 20 months—and because the agency is convinced the Atlas is able to perform the Mercury mission.

Last Mercury-Atlas (MA-3) launch Apr. 25 failed because of an electrical malfunction in the programmer. George M. Low, NASA manned space flight chief, said all indications point to a "good fix" and a modified programmer has been under test for two weeks.

MA-3 was destroyed by the range safety officer when it failed to pitch over, and the programmer was found buried in the sand at Cape Canaveral about a month after the launch. Low said finding the programmer, together with "detective work" by General Dynamics-Astronautics, Air Force Space Systems Division and Aerospace Corp., resulted in identification of 5-10 possible causes, traced to components not completely backed up. Minor design changes have been made in the programmer and circuitry in preparation for the fourth Mercury-Atlas launch, scheduled to be a complete capsule system checkout in a single orbit.

Atlas E Flight Test Program Reviewed

Washington—Special technical committee last week began a review of the USAF-Convair Atlas E flight testing program, which until that time had experienced seven failures in its first 10 launchings. An 11th launch attempt was scheduled for late last week.

The committee, headed by Dr. Clark Millikan, professor of aeronautics at California Institute of Technology, is trying to determine:

- **Whether the E model, which incorporates changes in the engines, airframe and guidance system compared with the D model, can still meet its original research and development objectives.**
- **If not, whether it is preferable to stay with the original test firing schedule and accept less data or to change the schedule enough to obtain all the data desired.**

Committee members include Trevor Gardner, president and board chairman of Hycon Manufacturing Co. and a trustee of Aerospace Corp.; Dr. Charles C. Lauritsen, another Aerospace trustee and professor of physics at CalTech; Dr. Ivan Getting, president of Aerospace; Dr. Hendrik Bode, Bell Telephone Laboratories; and Brig. Gen. C. J. Terhune, Jr., vice commander of Air Force Systems Command's Electronics Systems Division.

The committee was to visit Convair's Atlas plant at San Diego; AFSC's Ballistic Systems Division; Aerospace headquarters at El Segundo, and Space Technology Laboratories, Inc.

Nine of the first 10 Atlas E launch attempts were made from the Air Force Missile Test Center in Florida and one was an attempt to launch from the coffin-type of operational installation at Vandenberg AFB, Calif. Last week's attempt was to be made from Florida.

No pattern of trouble had developed in the first 10 launch attempts. The hydraulic system was blamed for the first two failures, but this was corrected and the hydraulic system performed properly in later shots.

White Urges Continued U.S. Bomber Program

Washington – Missiles have not proved their reliability, according to retired Air Force Chief of Staff Gen. Thomas D. White, and the U.S. should move ahead with production and development of manned bombers.

Gen. White, who retired July 1, pointed out that the Russians have flown a new heavy bomber. "The Russians are evidently going ahead with bombers. I think we should," he said during a National Broadcasting Co. Meet the Press show.

Commenting on nuclear power for aircraft, Gen. White observed that atomic energy is in its "infancy" and that he is sorry to see application of it to air power "go back so far."

In a related development, the Joint Congressional Atomic Energy Committee in its report on the Atomic Energy Commission authorization bill deplored "the apparent lack" of technical information on the Aircraft Nuclear Propulsion (ANP) program available to Defense Department officials when they decided to cancel it.

The joint committee said "classified information" showed that technical progress on ANP in the last two years was "exceptionally gratifying," adding one approach was far enough along to permit "design and construction of a full-scale nuclear engine for ground tests.

"A number of committee members were disappointed in the cancellation of the project," the report said. "Their primary concern stemmed from the apparent lack of information on the technical status of the work by those in the executive branch who supplied the information upon which the decision to cancel the project was based."

Air Force Reorganizes Deputy Chiefs of Staff

Washington—Offices of two Air Force deputy chiefs of staff have been reorganized in conjunction with the July 1 deadline for completing changes in the new Air Force Systems Command, Logistics Command and Office of Aerospace Research.

Lt. Gen. Mark E. Bradley, formerly deputy chief of staff-materiel, has become deputy chief of staff-systems and logistics (AW Apr. 10, p. 25). His assistant for logistics is Maj. Gen. William O. Senter, the assistant for systems is Maj. Gen. Joseph R. Holzapple and the director of systems acquisition is Brig. Gen. Milton D. Adams.

Gen. Bradley's new office combines responsibilities of development procurement, logistics support of aircraft, missiles and space and electronic systems. It will have authority over some research, advanced technology, studies requirements and development planning.

Deputy chief of staff for research and technology is Lt. Gen. Roscoe E. Wilson, who was deputy chief of staff-development. His assistant is Maj. Gen. Victor R. Haugen.

Director of Advanced Technology under Gen. Wilson is Maj. Gen. Marvin C. Demler. Director of research is Brig. Gen. Ralph L. Wassell, and director of development is Maj. Gen. William B. Keese.

This office is responsible for long-range plans, policy and objectives of Air Force research, and it will identify and support technical advances as the focal point in the Air Force for scientists.

Although the director of systems acquisition has responsibility for staff functions of development production and production review for most projects, the Minuteman ICBM and B-70 bomber will have their own systems officers reporting directly to Gen. Holzapple.

These special offices will exist only during the critical period in a project's cycle.

Scout Launch Fails With S-55 Satellite

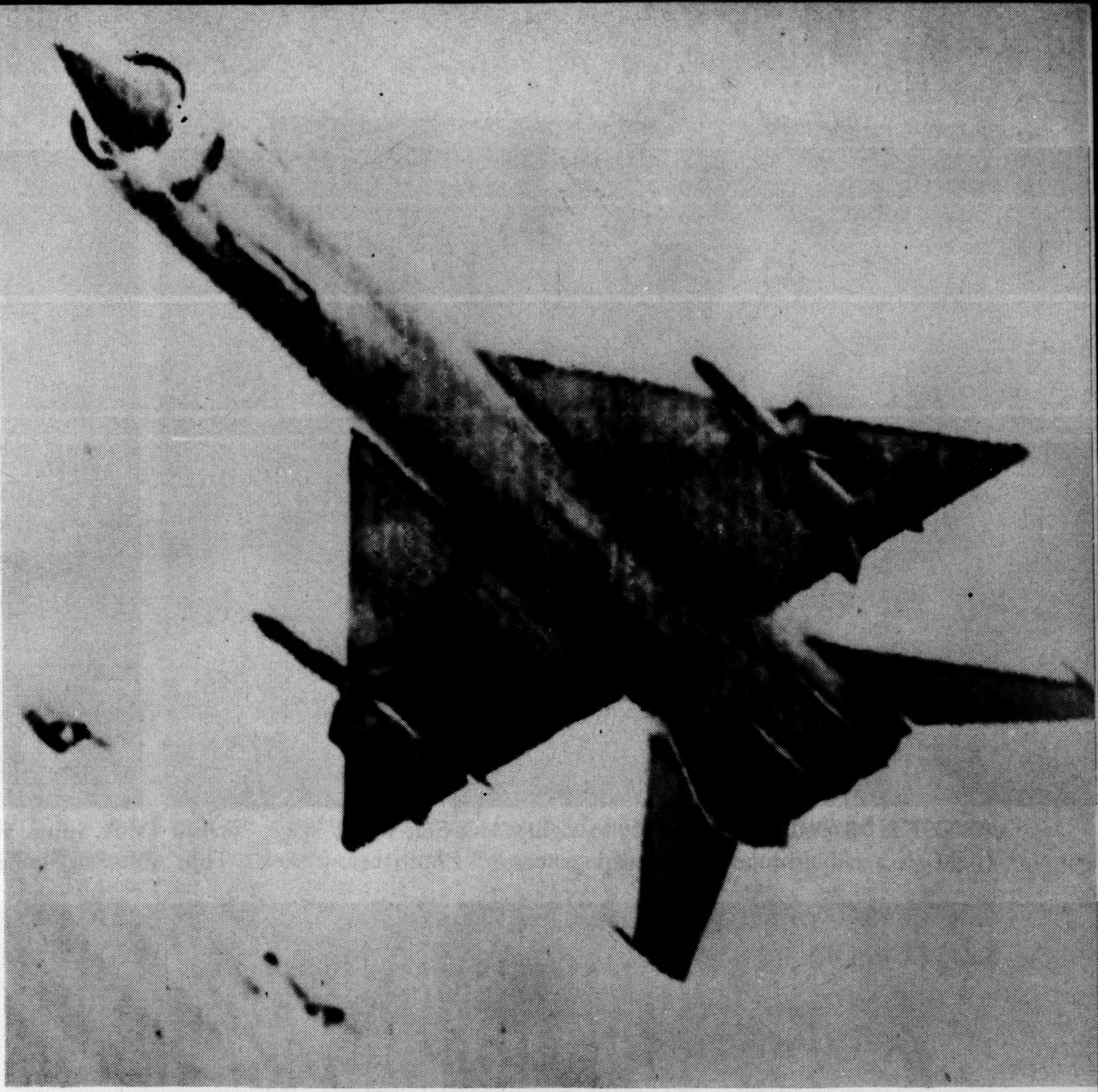
Washington—Attempt to place the five-experiment S-55 micrometeoroid satellite into orbit failed June 30 when the third stage of the four-stage Scout launch vehicle did not ignite.

The launch from Wallops Island, Va., was the fifth in a 10-vehicle Scout development program. Two ballistic tests were successful, and one of two earlier satellite launch attempts failed. Scout was used to launch the Explorer X inflatable air drag satellite into orbit Feb. 16 in its only successful orbital launch.

The S-55 package, which would have been called Explorer XII if it had been successful, consisted of these experiments:

- **Pressurized cell detector** system, designed by National Aeronautics and Space Administration's Langley Research Center, consisting of 160 half-cylinders mounted in five rows around the fourth-stage. The cells, pressurized with nitrogen, would detect micrometeoroid punctures by pressure loss.
- **Foil gage detectors**, designed by NASA's Lewis Research Center, consisting of 60 Mylar triangles mounted under type 304 stainless steel. Micrometeoroids puncturing the steel sections, which had two thicknesses, were to be recorded.
- **Wire grids**, essentially 46 copper wire sections wound on melamine cards in an experiment designed by NASA's Goddard Space Flight Center. Wires are designed to break when struck by micrometeoroids.
- **Two cadmium sulfide cells**, developed by Goddard, consisting of a Mylar-covered flask to measure the size of micrometeoroids striking it.
- **Crystal impact sensors**, mounted on sounding boards to determine impact velocity.

Langley Research Center integrated the payload into a cylindrical structure 76 in. long with a 24-in. diameter.

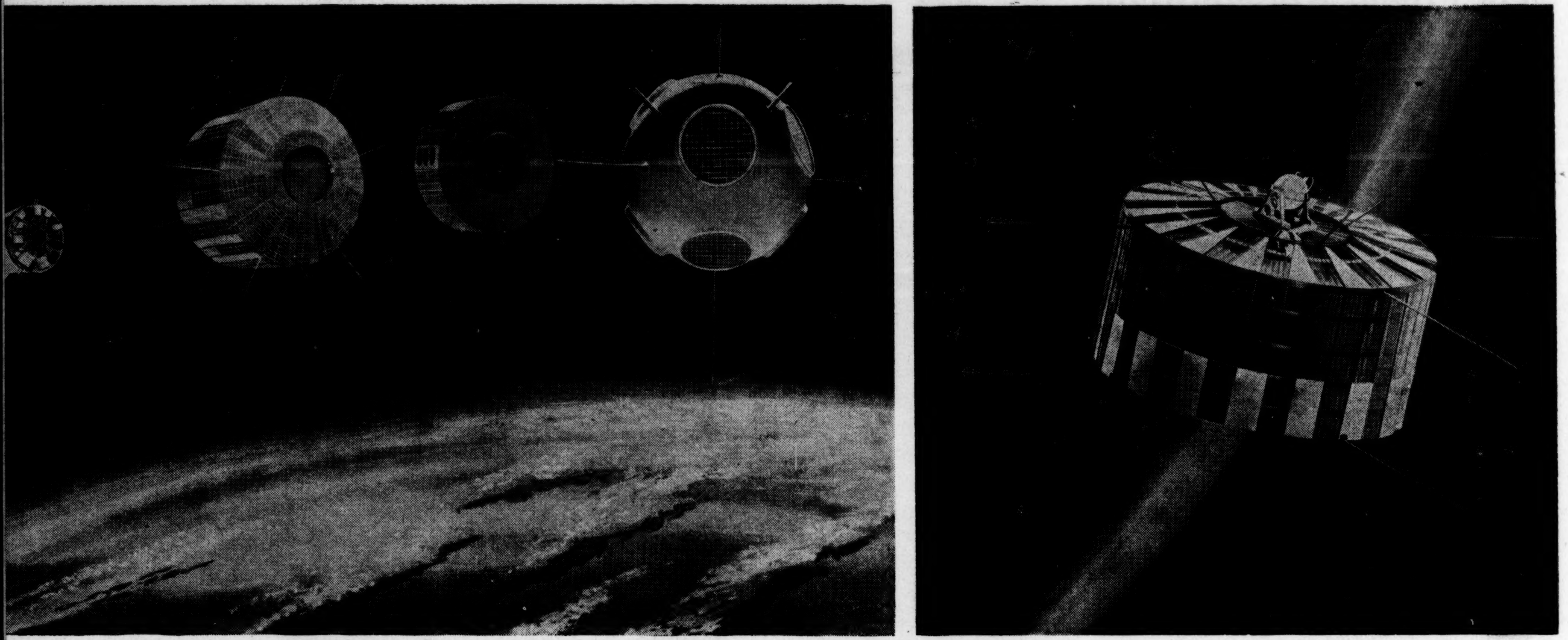


New Soviet Mach 2-Plus Fighter

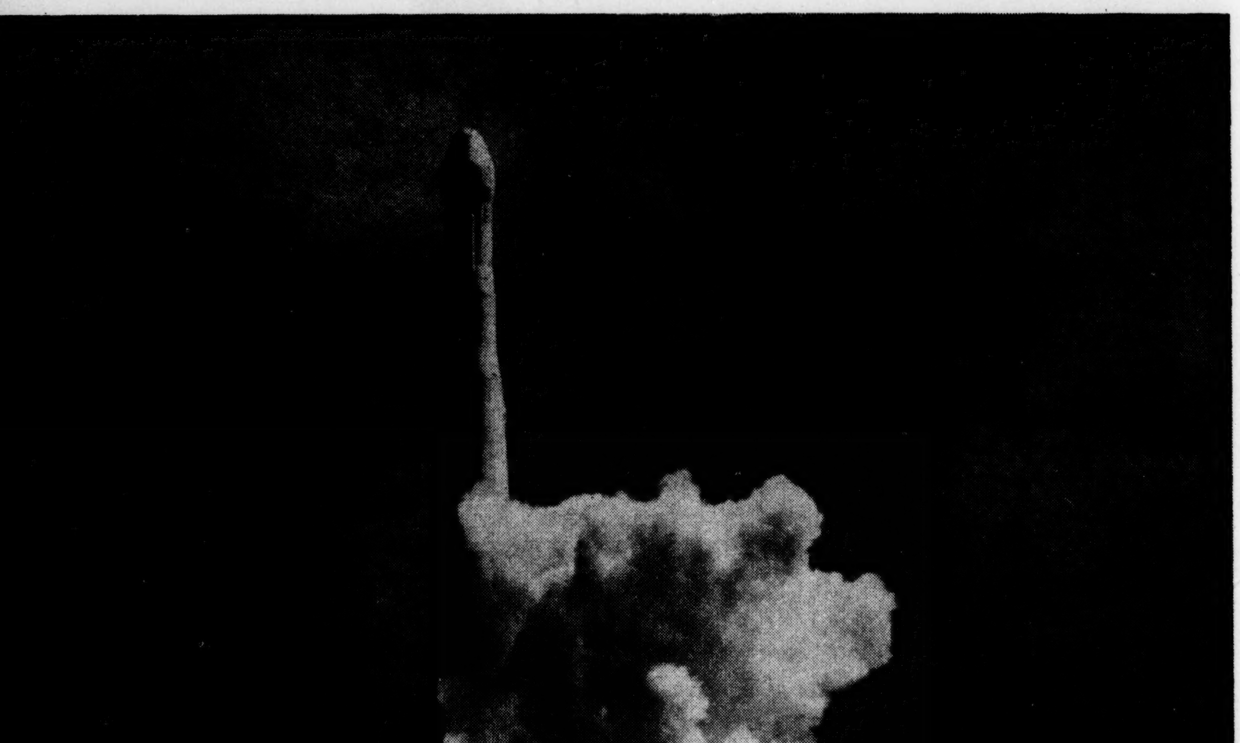
New supersonic Soviet long-range interceptor armed with air-to-air rockets has been seen by Western observers in the rehearsal flybys for the Tushino air show. This delta-winged fighter appears to be a Mikoyan design developed from his earlier Fishbed (AW Feb. 17, 1958, p. 87) but considerably faster and with longer range than this earlier Mach 2 design first exhibited in 1956. The new fighter is about 85 ft. long, has a single large air intake with a conical diffuser that houses airborne intercept radar. It appears to have three engine outlets at the tail, of which two may be turbojets with the third a large rocket boost motor. Air-to-air rockets appear to be infrared guided, similar to the de Havilland Firestreak. This new design is believed to be the aircraft the Soviets have designated the "E-66" in claiming world speed and altitude records for it of 1,335 mph. and 112,204 ft. Large formations of the earlier Fishbeds have been observed in the rehearsals carrying four air-to-air missiles slung under their wings. These Fishbeds also carry airborne radar.

Grissom to Fly MR-4

Air Force Capt. Virgil I. Grissom, 35, has been selected as primary pilot for the second Mercury-Redstone suborbital flight (MR-4), now scheduled July 18. His backup pilot will be Marine Lt. Col. John H. Glenn, Jr., who also was backup pilot for Cdr. Alan B. Shepard, Jr., in the first U. S. manned Redstone mission May 5.



ARTIST'S DRAWING shows (left to right) Able-Star upper stage, Transit IV-A, Injun and Greb. White sphere on the top of Transit (right) is a radioisotope-fueled Snap generator. Photo below shows Thor Able-Star similar to the one which made the actual launch.



Transit, Two S

By Larry Booda

Washington—Navy's Transit IV-A navigation satellite, carrying an atomic auxiliary power unit, is operating successfully and two smaller satellites launched with it are providing information on solar radiation and related phenomena despite the fact that the Injun and Greb III piggyback research satellites failed to separate from each other (AW July 3, p. 33).

The 175-lb. Transit package was "working perfectly" a few days after launch, Navy said. Air glow observations which would have been performed by the photometer carried in the 35-lb. Injun will not be possible because the sensor is covered physically by the 55-lb. Greb satellite.

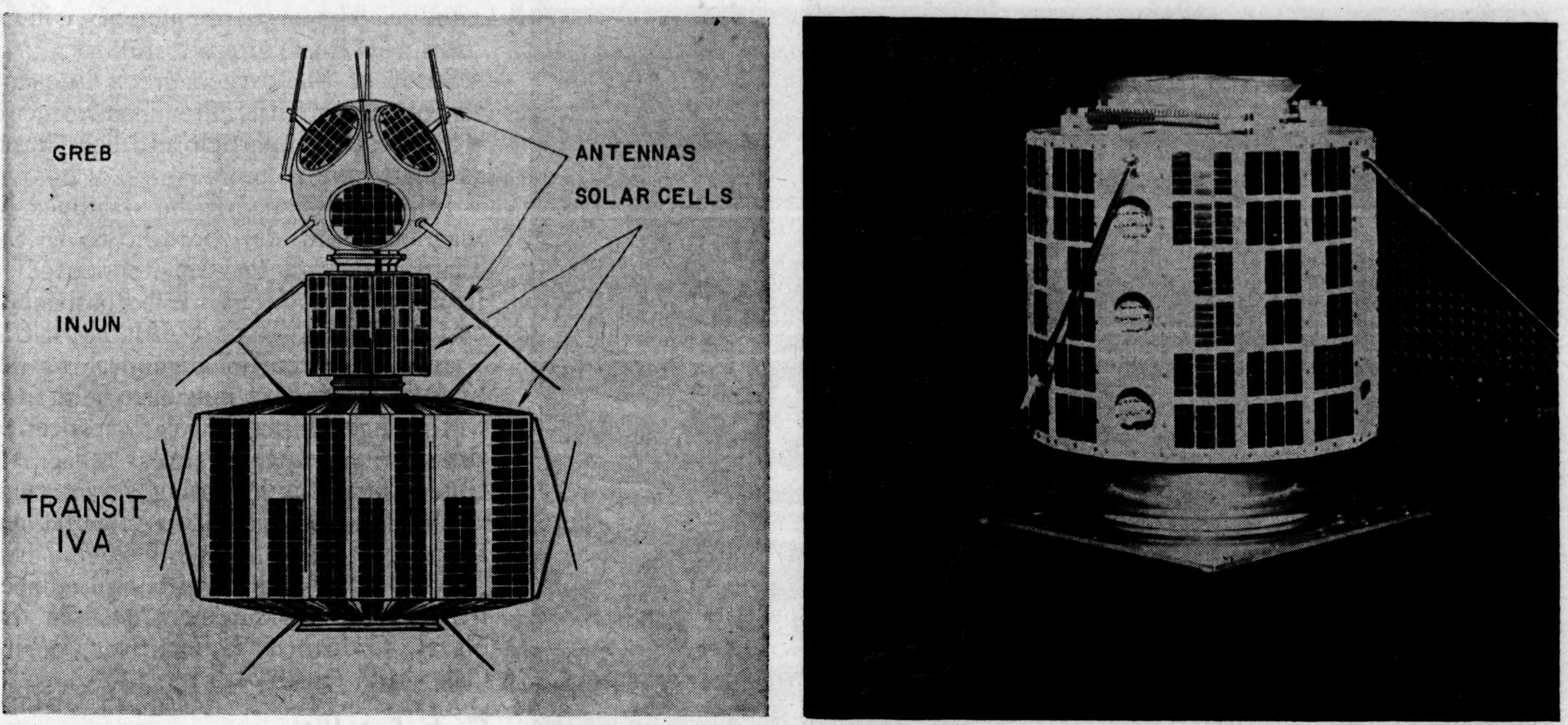
Project Moonwatch

In the first and second passes after launch, Project Moonwatch teams and Baker-Nunn camera stations reported three objects. There should have been four—the three satellites and the final stage. On the next day, telemetry confirmed the failure of the two smaller satellites to separate.

Transit transmissions on 54 and 320 megacycles indicated that the radioisotope thermoelectric generating unit and the solar cells powering two other transmitters were functioning properly.

Previously the Administration had refused to allow the power unit to be placed in Transit for a launch once scheduled for June 6, but reversed its ruling and permitted it to be carried in the June 28 shot (AW July 3, p. 25).

The nuclear power device measures



TRANSIT IV-A and its two piggyback satellites Injun and Greb are depicted (left) as assembled in nose cone. Closeup of Injun is shown at right. Injun is designed to be stabilized by magnetic attitude control to keep it properly oriented.

o Small Satellites Work Despite Malfunction

5 in. in diameter in one direction and 5.5 in. long. It weighs 4.5 lb. and is fueled with plutonium 238. It is based on the previously demonstrated Snap 3 unit, which was powered with polonium 210, and is more powerful.

A comparison with conventional power sources can be made with the Snap 3 unit, which can produce the power equivalent of 1,700 lb. of nickel-cadmium batteries and solar cells in 280 days.

The generator is contained in a rugged capsule—prototypes of which were subjected to high impact stresses and heat from kerosene fires. It was the safety testing program of the Atomic Energy Commission which helped swing Administration opinion in favor of space launches for the devices.

Spontaneous decay of the radioactive plutonium 238 generates heat, which, in the block surrounding it, enters thermocouples which convert it to electrical energy. The unit produces three watts of power. All such devices produce low voltage and high current.

Plutonium 238, an alpha particle emitter, has a half life of about 90 yr., making it theoretically capable of producing power for decades. However, in the Transit installation the goal is 5 yr. of service. Cost of the generator without the fuel is $4,800. AEC has applied the radioisotope generator principle to powering remote weather stations (see box p. 28).

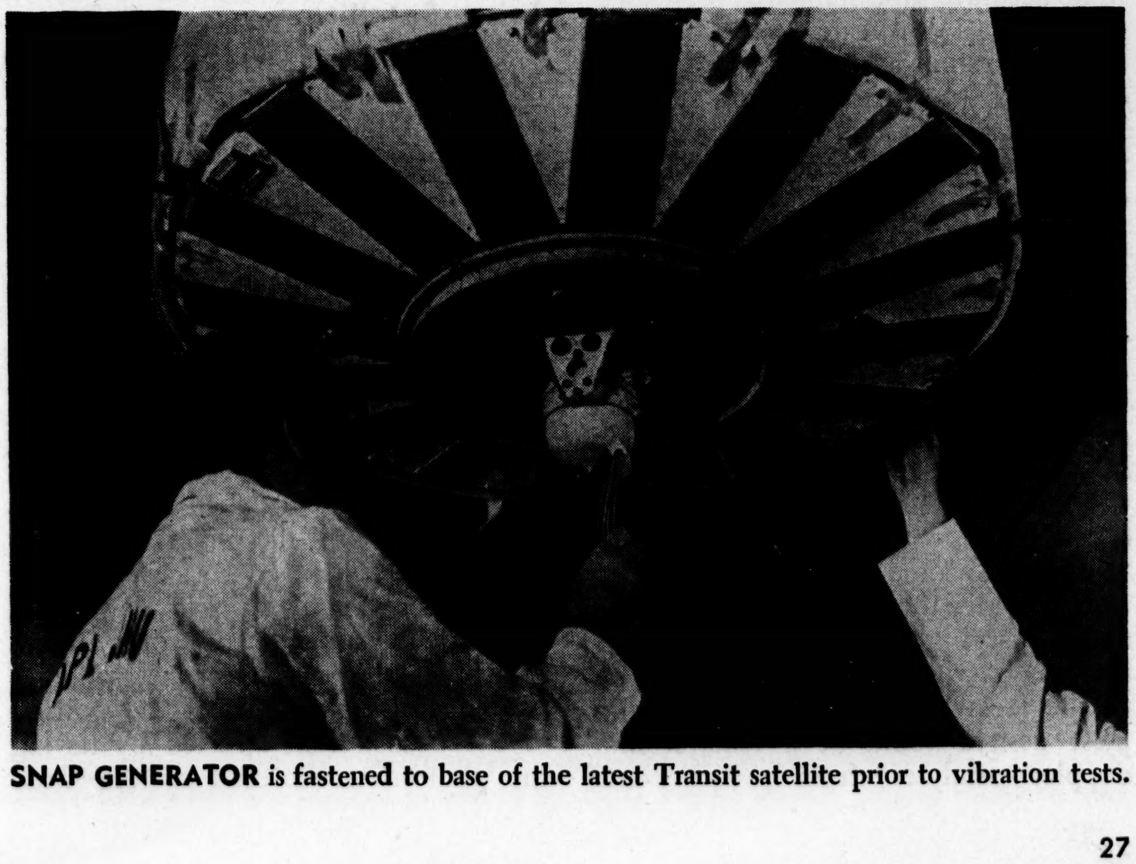
The Transit power unit was developed by the Martin Co. for AEC and the fuel core was loaded by AEC's Mound Laboratory at Miamisburg, Ohio, which is operated by the Monsanto Chemical Laboratory.

AEC officials spent considerable time in a press conference emphasizing the safety angles of Snap type power units, calling the capsule "virtually indestructible." AEC Chairman Glenn Seaborg said he would have no fear of sitting on the power unit's fuel element. He compared the amount of radiation emitted by the plutonium 238 in one hour to the amount emitted during a dental X-ray. Radioisotopes must be ingested through the alimentary tract or the lungs in order for the radioactive elements to reach the bones where they can do damage to the blood-producing marrow.

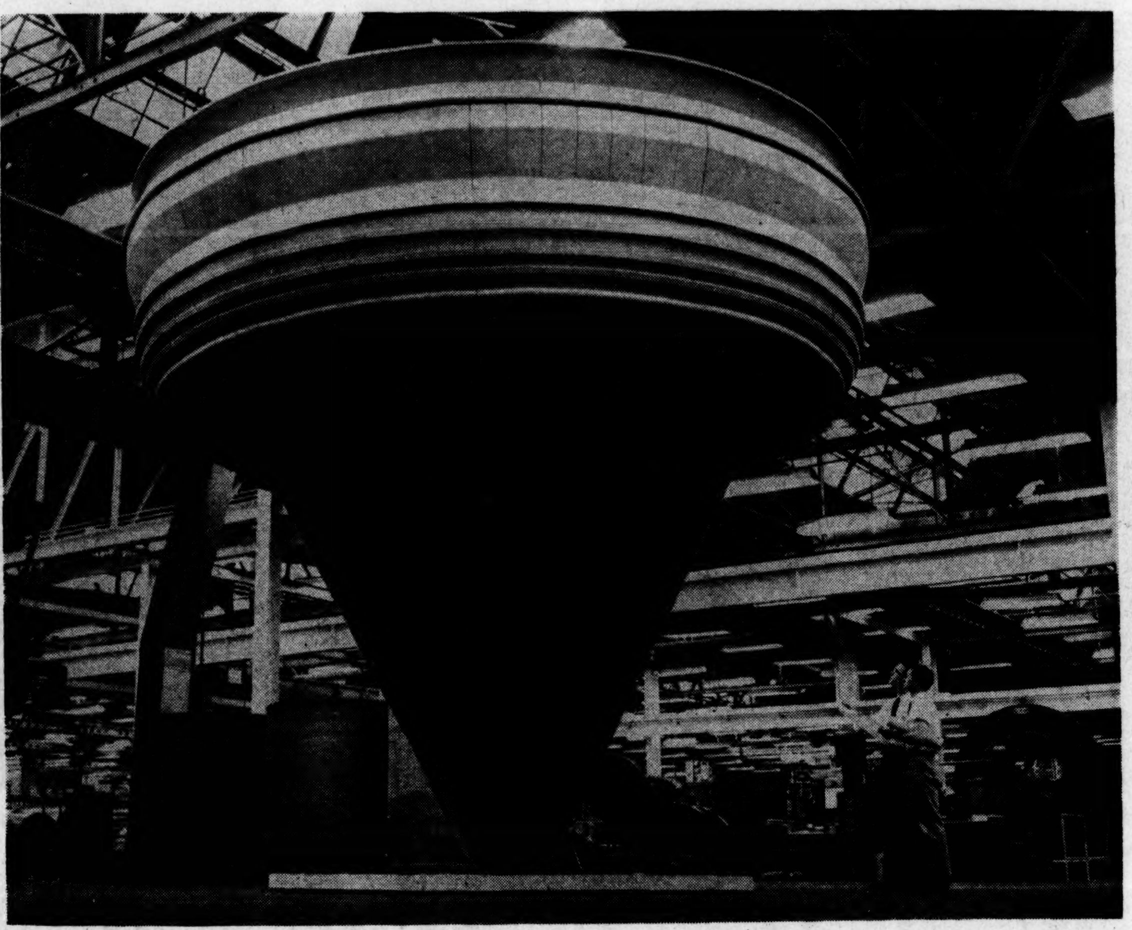
Transit IV-A is a polygon of 16 sides with a flat top and bottom. It is 43 in. in diameter and 31 in. high. This is the third launch classed as either successful or partially successful. Navy considers that five or six prototype launches will be necessary before the system becomes operational.

Operational satellites will be smaller in size and will be placed in polar orbits from the Pacific Missile Range's naval facility at Pt. Arguello, Calif. Four operational satellites will initially be spaced quadrantly.

As a byproduct of the memory readout system of the latest Transit (AW Feb. 27, p. 34), a new and more accurate time standard will be made avail-



SNAP GENERATOR is fastened to base of the latest Transit satellite prior to vibration tests.



GE Plug Nozzle Rocket Mockup Unveiled

General Electric Co.'s plug nozzle rocket concept, expanded to a 2.5-million-lb. thrust rating, is shown in this engineering mockup. Over-all height of engine is 15 ft.; diameter is 18 ft. Turbopumps and auxiliary equipment would be housed in conical external expansion plug, and base of the propellant tankage would attach directly at the top of the cone thrust structure in any application. Plug nozzle would have 13 segments.

able over the surface of the earth. Current time standards are available by radio transmissions from such stations as WWV of the National Bureau of Standards. Such transmissions are subject to variations in reception time because of the fluctuations of the ionosphere which refracts the signals back to earth.

Absolute time standards, accurate to several milliseconds, are needed in many applications. Militarily, ballistic missile guidance is highly dependent on the more accurate time standard.

Transit IV-A carries a magnetic memory system. It is being fed orbital data every 12 hr. from ground stations. Every 11.18 sec. it will broadcast its precise position over the surface of the earth.

Frequency Divider

These broadcasts will be triggered by a frequency divider consisting of 25 transistorized circuits controlled by a highly stable, 3,000-kilocycle crystal oscillator. This timing of pulses of the broadcast will be more accurate than the system of standard time broadcasts described above.

Eventually the navigation information provided by Transit will be available in varying degrees of accuracy, depending on the degree of sophistication of the receiving equipment. The simplest design would be a receiver and doppler analyzer from which data would be taken and computed on a slide rule, producing accuracies of about 1.0 mi.

In order to produce accuracies of 0.1 mi., the ultimate Navy aim, more accurate equipment and computers will be needed.

Data are being transmitted to Transit from the headquarters of the Johns Hopkins University's Applied Physics Laboratory at Silver Spring, Md., where the Transit satellites are being developed for the Office of Naval Research.

Injun Satellite

Injun satellite was designed and fabricated by Dr. James Van Allen of the State University of Iowa under contract with ONR.

Injun is designed to conduct the following measurements somewhat modified in this instance because of the failure of the piggybacks to separate after launch:

- **Detailed plotting** of the auroral zones.
- **Simultaneous plotting** and monitoring of the Van Allen outer radiation zone.
- **Measurement of charged** particles trapped in both the inner and outer Van Allen belts.
- **Measurement of particle** down flux from the equator to the polar auroral zones and observations of air glow and auroral emissions. This is the portion of the observations affected by having the photometer covered by the Greb satellite. However, phenomena will be measured from ground stations.
- **Study of the oxygen** green line and its connection with auroral phenomena.
- **Study of both particle** and light fluxes associated with aurora.

Injun is designed to be stabilized by magnetic attitude control, as is the Transit payload, to keep it oriented so its radiation counters will be positioned correctly with respect to the earth. Transit must remain aligned along the lines of the earth's magnetic field so it will change its position with respect to the sun and expose its solar cells. Attitude control is operating slower than intended because the two satellites are together.

Both Injun and Transit were subject to magnetic measurement test at the Naval Ordnance Laboratory, White Oak, Md.

Greb Satellite

The Greb III, also called Naval Research Laboratory's Solar Radiation III satellite, is designed to measure the level of X-ray radiation from the sun. During solar storms greater quantities of X-rays are emitted, causing changes in the ionosphere and consequently affecting radio communications.

Data from this satellite are expected to shed light on the relationship between sunspot activity, solar X-ray emission and radio wave propagation on earth.

Greb, unlike its two predecessors, which contained one ultraviolet detector and one X-ray sensor each, carries two X-ray sensors. It has been discovered that ultraviolet emissions remain constant during solar storms. Thus two X-ray sensors will be able to cover a greater range of emissions.

Greb is designed for a 1-yr. life. Because it is fastened to Injun, it is rotating slower than intended, and is transmitting about half as much data as planned.

Atomic Weather Station

Washington—Atomic-powered automatic weather station, first of its kind, has been transmitting from a Martin Co. site in Baltimore to the Atomic Energy Commission's downtown offices here. The unit receives its power from the beta particle emissions of strontium 90, which has a half life of 27 yr.

The station, designed for about two years of unattended operation in remote locations, is 8 ft. long and about 20 in. in diameter. It broadcasts barometric pressure, humidity, wind direction and velocity and precipitation.

Work is proceeding on a station which could be parachuted into remote locations. Development is expected to be completed early next year.

Disarmament Research Effort Proposed

Washington – U.S. Disarmament Agency for World Peace and Security, proposed to Congress by President Kennedy, would undertake a vastly expanded program of research and development in weapons detection and monitoring technology.

To accomplish the program, the $22,500-a-year presidentially-appointed director of the agency would be authorized to coordinate the activities of other government agencies—mainly Defense Department and Atomic Energy Commission—and use their facilities, to construct new facilities and laboratories "as he deems necessary," and to let contracts and make grants to private institutions.

Specific Projects

The projects specified in the proposed legislation for the new agency, extending from studies to the practical development of arms control devices and methods, include:

- "**Detection, identification,** inspection, monitoring, limitation, reduction, control and elimination of armed forces and armaments, including thermonuclear, nuclear, missile, conventional, bacteriological, chemical and radiological weapons;
- "**Techniques and systems** of detecting, identifying, inspecting, and monitoring of tests of nuclear, thermonuclear and other weapons;
- "**Control, reduction and elimination** of armed forces and armaments in space, in areas on and beneath the earth's surface, and in underwater regions;
- "**Training of scientists,** technicians, and other personnel for manning the control systems which may be created by international disarmament agreements;
- "**Reduction and elimination** of the danger of war resulting from accident, miscalculation or surprise attack, including (but not limited to) improvements in the methods of communications between nations;
- "**Methods for the maintenance** of peace and security during different stages of disarmament."

In addition to performing preparatory work for the establishment of inspection and control systems, the new agency would also have responsibility for their operation—when and if they are put into effect.

The President declared in a message accompanying the legislation that "the ingenuity that has made the weapons of war vastly more destructive should be applied to the development of a system of control of these weapons."

In developing the legislation, the President said, his disarmament adviser, John J. McCloy, "consulted closely" with Secretary of State Dean Rusk, Secretary of Defense Robert S. McNamara, and AEC Chairman Glenn T. Seaborg. He noted that an effective disarmament program will require that "close working-level coordination and cooperation be established" between the new agency and State, Defense, and AEC.

The legislation authorizes the detailing of military personnel to the agency without prejudice to their status or advancement in the services. It also provides that three retired officers "who are experts in military strategy or weapons systems" may be employed by the agency without loss of retirement benefits.

The agency would also undertake extensive programs aimed at economic and psychological adjustment to disarmament—at home and abroad.

Projects specified are:

- "**Analysis of national budgets,** levels of industrial production and economic indicators to determine the amounts spent by various countries for armaments;
- "**Economic and political** consequences of disarmament, including the problems of readjustment arising in industry and the reallocation of national resources;
- "**Disarmament implications** of foreign and national security policies of the U. S. with a view to a better understanding of the significance of such policies for the achievement of disarmament;
- "**Scientific, economic,** political, legal, social, psychological, military, and technological factors related to the prevention of war with a view to a better understanding of how the basic structure of a lasting peace may be established."

Kennedy's Comments

Noting that "peace cannot be brought about by concentrating solely on measures to control and eliminate weapons," the President said:

"A disarmament program must take into account the national security, our foreign policy, the relationships of this country to international peace-keeping agencies, including the United Nations, and our domestic economic and other policies. It should drive toward the creation of a peaceful world society in which disarmament, except for the forces needed to apply international sanctions, is the accepted condition of international life."

The semi-autonomous agency would succeed the Disarmament Administration established within the State Department last October by former President Eisenhower, which has expanded in recent months to a staff of approximately 90 and an annual budget of $800,000. Under present plans, the new agency would have a staff of about 250 and an annual budget of $6 million in its first year of operation.

The agency's director would operate under the direction of the President and the Secretary of State, and also serve as disarmament adviser to the President. Explaining this arrangement, McCloy said:

"This . . . recognizes that disarmament considerations are so all-pervasive in scope and importance that the President must concern himself with these matters on a continuing basis.

"It also recognizes the fact that disarmament policies, negotiations and programs must be very closely coordinated with State Department activities and responsibilities."

Under the director would be a $21,500-a-year deputy director and four $20,000-a-year assistant directors. A General Advisory Council of 15 members appointed by the President would advise the director.

Agency Functions

The legislation gives the agency responsibility "to provide the essential scientific, economic, political, military, psychological and technological information upon which realistic disarmament policy must be based."

It lists four general functions:

- "**Conduct, support** and coordination of research for disarmament policy formulation.
- "**Preparation for and direction** of U. S. participation in international negotiations in the disarmament field.
- "**Dissemination and coordination** of public information concerning disarmament.
- "**Preparation for, operation** of, or as appropriate, direction of U. S. participation in such control systems as may become part of U. S. disarmament activities."

Pratt & Whitney Wins Test Facility Contract

Washington—Pratt & Whitney Connecticut Aircraft and Nuclear Engine Laboratory has been awarded a $589,000 contract to design and build a test stand for ion and nuclear power heat radiators at Lewis Research Center.

The National Aeronautics and Space Administration facility, to be completed in 15 months, will include an environmental test section 18 ft. long and 8 ft. in diameter. Closed loop working test section will be capable of radiating heat loads up to 1,800F.

Third Tiros Test Flight Scheduled To Cover 1961 Hurricane Season

Washington—Third weather satellite in the Tiros series is scheduled to be launched this week from the Atlantic Missile Range by a Delta vehicle, with an operating lifetime designed to coincide with the 1961 hurricane season.

Instrumentation in the 285-lb. package is similar to that in previous Tiros satellites, with improved remote programmers for electronic equipment and newly-designed transistor circuitry in clocks which trigger the cameras.

Tiros III will have two wide angle videcon cameras covering about 750 mi. of the earth's surface at a resolution of 1.5-2 mi. Narrow angle cameras, used in both Tiros I and Tiros II have been eliminated, according to the National Aeronautics and Space Administration, because data from the wide angle system has proven more valuable for weather analyses.

The television cameras have a lens speed of f1.5 with a shutter speed of 1.5 milliseconds. Video bandwidth is 62.5 kc.

Each camera can record and store on 400 ft. of video tape 32 photographs during each 98-min. orbit. The satellite is to be launched into a 400-mi. circular orbit. The package is covered by 9,260 solar cells which will provide energy to 63 nickel cadmium storage batteries.

In addition to the camera system, instruments in Tiros III are:

- **Three infrared experiments:** one a scanning device containing five sensors, and two non-scanners. The scanning system will map reflected solar radiation, long wave radiation from the earth and atmosphere, cloud top temperatures, and atmospheric level (25,000 ft.) temperature. Both non-scanning sensors will measure gross heat budget, one continuously and the other on command.
- **Horizon sensor,** also an infrared device mounted on the satellite rim, which determines the satellite attitude.
- **North indicator,** essentially a series of solar cells which relay data on the position of the satellite in relation to the sun.
- **Magnetic orientation control,** a wire coil around the lower portion of the satellite which generates a magnetic field to tilt the package on ground command.

Primary ground command and data readout stations are at Wallops Island, Va. (AW June 5, p. 23) and the Pacific Missile Range. Backup stations are at the Atlantic Missile Range and the Radio Corp. of America's Princeton, N. J., facility.

Cloud cover pictures will be photographed at ground stations, and infrared tapes will be analyzed at NASA's Goddard Space Flight Center.

Astro-Electronics Division of RCA designed and built the satellite and ground stations. Barnes Engineering Co. designed two radiation detectors, and the University of Wisconsin designed the third.

LingTemcoVought,Inc. To Shift Subsidiaries

Dallas—Stockholder approval of the merger between Ling-Temco Electronics and Chance Vought into Ling Temco Vought, Inc., will be followed by organizing the former two companies' facilities and subsidiary organizations into seven new corporate groups (AW Apr. 3, p. 29).

Although officials of Ling Temco Vought decline to discuss specific makeup of the new company, indications are that it will take this order:

- **Aerospace Systems,** consisting of Chance Vought Corp., which will be a subsidiary of LTV will contain Vought's former Aeronautics and Missiles Division, Astronautics Division, Range Systems Division and Harbor Boat Co.
- **Electronics Group,** called the LTV Electronics Division, will consist of Temco Electronics Division, Vought Electronics, Micromodular Components Division and United Electronics.
- **Communications and Test Systems** Group which probably will be tagged the LTV Communications and Test Systems Division will comprise Continental Electronics Manufacturing Co., Ling Electronics, the Calidyne Co. and Electron Corp.
- **Commercial and Industrial Products** Group probably will consist of Temco Industrial Division, Friedrich Refrigeration, and Vought Industries, Inc.
- **Sound Systems Group** will include Altec Lansing Corp., Altec Service Co., Peerless Electrical Products Division, University Loudspeakers, Inc., and Columbia Cabinet Corp.
- **Aerosystems Group,** will have Temco Overhaul and Aerosystems.
- **LTV Information Handling Systems** Group, will comprise Information Systems, a Vought subsidiary, FF&M Electronics Inc., and National Data Processing Corp., also a Vought subsidiary.

Management of Ling Temco Vought Inc., will consist of—Robert McCulloch, chairman of the board and chief executive officer, James J. Ling, chairman of the executive committee, Gifford K. Johnson, president, Clyde Skeen, executive vice president, Raymond C. Blaylock, vice president-technical director, Lee D. Webster, vice president-secretary and treasurer and James J. Kerley, vice president-controller.

New headquarters will be established at Dallas-Grand Prairie, where Chance Vought and Temco's main production facilities are located, but former Ling-Temco executives pointed out that although they are moving from their former Garland offices, the program called for continued build-up of that plant's engineering and production. Work will continue in extensive environmental and other testing laboratories at Garland. Consumer products production, such as the company's new dishwasher, is being expanded and electronics assembly work there is also expected to increase.

Formal move of Ling-Temco and Chance Vought Corp. executives into **new headquarters** probably will not be made until Aug. 31.

AT&T, NASA Confer On Satellite Launching

Washington — American Telephone and Telegraph Co. and the National Aeronautics and Space Administration are completing negotiations for the launch of an AT&T-developed communications satellite.

The agreement, expected to be signed before the end of this month, will call for launch of a 130-lb. active repeater into a 5,000-mi. circular orbit by a Delta vehicle at no cost to the government. Launch probably will be made next year after NASA has orbited the government-developed Relay I active communications satellite.

The AT&T project will be the first negotiated under a government offer proposed by the Eisenhower Administration (AW Oct. 17, p. 26) and continued by the Kennedy Administration. In order to keep commercial development integrated with the national program for a communications satellite system, however, NASA will administer the AT&T contract through its Goddard Space Flight Center.

NASA looks on its Relay satellite as an experimental system, to demonstrate capability and assess component lifetimes. AT&T feels its satellite will be an operational prototype.

Meanwhile, NASA awarded a $450,000 contract to Douglas Aircraft Co. last week to study orbital techniques and design parameters for the Rebound rigid sphere passive satellite.

The agency plans to launch two Atlas Agena B vehicles in 1963, each with payloads of three 135-ft. inflatable spheres.

Seventh Army Gets First Mohawk; STOL Aircraft Tours Europe

Geneva—First Grumman Mohawk turboprop reconnaissance aircraft has been delivered to the U. S. Army in Europe as a prelude to scheduled deliveries to operational units this fall.

Delivery of the aircraft to the U. S. 7th Army at Sandhofen Air Base near Mannheim, Germany, by Grumman Chief Test Pilot Ralph Donnel followed an extensive European tour in which the Mohawk's STOL capability was demonstrated to American personnel and to European military officials. Aside from its planned mission with U. S. units, Grumman hopes the Mohawk may be ordered by one or more West European nations in line with its recent licensed production agreement with France's Louis Breguet (AW May 19, p. 24).

The agreement, however, is broad enough in scope so that Grumman could offer licensed production to firms of other European nations if orders from their respective countries hinged upon such an agreement. Breguet's counter agreement with Grumman giving the latter production rights to the Atlantic turboprop anti-submarine aircraft if it should be ordered in quantity by the U. S. Navy is equally broad, since the American government would have the final say as to whom the American manufacturers would be.

Grumman demonstration aircraft, flown to Europe primarily to show its capabilities at the recent Paris Air Show attended by defense officials from a number of countries, appeared at a total of 29 air fields, including Le Bourget, in exhibitions before delivery to the 7th Army.

Aside from its reconnaissance capability, German army interest centered around the Mohawk's capability as a weapons carrier, a role denied it under current Defense Department restrictions on U. S. Army roles and missions.

When being evaluated by the Marines, however, the aircraft was fitted to carry six external weapons stores, three under each wing, weighing a total of 4,740 lb. Aside from photographic reconnaissance, the Mohawk also can be used for infrared detection missions and, through the installation of an electronics boom mounted beneath the fuselage, for roles requiring the use of side-looking radar.

In the event of any European production, Grumman is considering substitution of the present two 1,005-eshp. Lycoming T53-3 engines with two de Havilland Gnomes of 1,150 eshp. each adapted to turboprop configuration. The company also is suggesting to potential customers the 1,150-eshp. -7 version of the T53 scheduled to become available sometime next year. The T53-7 engines would boost maximum speed of the aircraft from just under 300 mph. to slightly above 300 mph.

During its European tour, the Mohawk operated from one airfield located within four and one-half miles of the East German border, according to Grumman officials and, on two other occasions, from bases within six miles of the border. The standard performance included a low-altitude single-engine pass with a turn and roll into the dead engine.

Proposals Submitted For Lift-Fan Vehicle

New York—U. S. Army is expected to soon announce its choice of airframe manufacturer to develop a test vehicle for General Electric Co.'s lift-fan concept.

Six airframe companies—Bell, Convair, North American, Northrop, Ryan and Sikorsky—have submitted proposals. Observers understand that cost-sharing will be one factor weighing in the final choice.

Specifications call for a maximum speed of 450 kt. and a minimum thrust-weight ratio of 1.2. Fuel is to provide for 20 min. of sea-level operation on a hot day. Instrument flight capability, spelled out in the specification as a half-hour control capability under IFR rules, is expected.

Performance levels of the fan required to meet specifications have been demonstrated earlier by General Electric in a test program. Flight vehicle will be used to investigate speed regimes in both VTOL and STOL modes.

News Digest

British European Airways is considering the purchase of three Boeing Vertol 107 helicopters for cross-channel service connecting London with Sabena's heliport in Brussels. Vertols would be interim helicopters pending a Rotodyne production decision.

Australian government has ordered 27 Westland Wessex ASW helicopters for the Royal Australian Navy, in a $14-million order, after evaluating the Wessex against the Bell Iroquois and Kaman Seasprite.

Raytheon has an $11,577,912 Federal Aviation Agency contract for 40 bright radar display systems, the first of which is scheduled for delivery next spring. The new equipment, to be installed in FAA's Air Route Traffic Control Centers, uses scan conversion to provide a radar picture of area traffic that controllers can see in a normally lighted room. Ten FAA centers and four airport control towers now are partially equipped with bright display systems.

Civil Aeronautics Board has stayed its order granting a blanket exemption to Saturn Airways to operate transatlantic passenger charters without prior Board approval while it considers protests of Pan American World Airways and Trans World Airlines.

Boeing Co. has received a $100,000 National Aeronautics and Space Administration contract to study design problems of large solid rocket launch vehicles (AW June 26, p. 26). NASA will use the information in writing specifications for the solid Nova, to be developed by the Air Force to meet NASA requirements.

Military Air Transport Service has amended its Fiscal 1962 contracts for Logair and Quicktrans commercial airlift to conform with minimum rates specified by Civil Aeronautics Board (AW June 12, p. 37). However, MATS reports that if after 90 days CAB rules the new rate floors must be continued, the dollar volume of the Fiscal 1962 contracts will be decreased pending a request for more money.

Israel fired a three-stage solid rocket containing a sodium flare payload to a 50-mi. altitude last week in a meteorological experiment designed to measure wind activity in the upper atmosphere. U. S. and Italy have conducted similar experiments using Nike-Asp and Nike-Cajun rockets.

Civil Aeronautics Board reorganization plan went into effect July 3 after the Senate reversed Government Operations Committee action and approved it (AW, July 3, p. 36).

Allegheny Airlines and National Car Rental System have signed an agreement under which the carrier will acquire a 50% interest in National. National, which concentrates its activities in the west and south, will expand its operation to include cities served by Allegheny. National serves 500 U. S. cities and operates 12,000 cars.

Smathers to Ask New Foreign Air Policy

President Kennedy to be urged to take new approach involving CAB review of all foreign carrier permits.

By L. L. Doty

Washington—President Kennedy will be asked to establish a new foreign policy on international air transportation which would involve a full-scale review by the Civil Aeronautics Board of current foreign air carrier permits.

Sen. George A. Smathers (D-Fla.), a leading opponent of State Department policy on air transportation, had arranged last week to meet with the President to propose the new policy. Sen. Smathers will invite CAB Chairman Alan S. Boyd and Federal Aviation Agency Administrator N. J. Halaby to join him in the White House conference. Sen. A. S. Mike Monroney (D.-Okla.) also may be a member of the group.

Sen. Smathers told Aviation Week he is now preparing a memorandum for President Kennedy in which major issues involved in the international air transport situation are outlined.

Sen. Smathers' proposed policy is based on the principle that the President has full power to amend any or all air carrier permits now in effect and that the CAB has the responsibility for maintaining "constant surveillance" of foreign flag carrier operations to uncover any violations of bilateral air transport agreements that would require amendment of permits.

His basic concern is the dwindling U. S. share of traffic on international routes. What he wants is a formal presidential policy that would grant the CAB full authority to revise air carrier permits in such a way that U. S. flag carriers would be protected against inroads of foreign competition on overseas routes serving U. S. gateways. He also will seek cancellation of foreign air carrier permits held by carriers found to be cutting rates below IATA standards.

Sen. Smathers feels strongly that routes authorized in foreign air carrier permits exceed those, in many cases, intended in bilateral agreements and that immediate adjustments should be made. His "get-tough" approach to the bilateral issue stems from impatience with the manner in which the State Department has negotiated agreements with foreign governments and the way the agreements have been carried out.

Congressional Discussion

International air transportation problems have prompted an increasing amount of congressional floor discussion in recent weeks, but most observers feel that very little will develop from the present furor. There have been several resolutions and a bill introduced this year in Congress on the issue, but the Smathers move is the first tangible congressional action taken in response to pleas of U. S. flag carriers for government assistance in halting growing competition on international routes.

Although Sen. Norris Cotton (R.-N. H.) has introduced a resolution calling for an investigation of international aviation, hearings will not be scheduled at least during the current session of Congress. Later, Sen. Andrew F. Shoeppel (R.-Kan.) introduced a bill which would require that all international agreements be sent to the Senate for ratification as treaties.

Similar legislation has been introduced on several occasions in the past without drawing favorable action. However, because of the wide publicity attached to the international air transport issue in recent weeks, the Shoeppel bill is receiving strong Senate support.

Members of the Senate Commerce Committee, to which the bill has been referred, are optimistic over the prospects of it becoming law. In general, the airline industry is not expected to give the bill its support because of a sharply divided opinion as to whether

Rusck Resigning as SAS President

Oslo—Ake Rusck, president of the International Air Transport Assn., is resigning under pressure from his post as operating head of the financially-pressed Scandinavian Airlines System.

Rusck's resignation as SAS president, which becomes effective this week, was announced here in a brief statement following a regular session of the board of governors which said only that "according to an agreement at the meeting, Mr. Rusck will resign."

Swedish industrialist Curt Nicolin, president of ASEA, a major manufacturer of electrical equipment, will step in on a temporary basis as caretaker president of the airline. An SAS official said last week that the new president is "purely on a loan basis" until the board can name a permanent president, and Nicolin announced that he definitely intends to return to ASEA.

Rusck, president of SAS since Jan. 1, 1958, declined comment on any future plans, saying only that his first step will be a vacation. Prior to joining the airline, he had served as president of the Swedish Water Power Board.

His one-year term as IATA president was due to expire with the installation of new officers at the organization's annual meeting this fall. SAS spokesmen said they could not speculate as to the effect the resignation would have upon Rusck's status as IATA president. They added, however, that, to their knowledge, this marked the first time an IATA president has left his airline position during his active term of office with the organization. International Air Transport Assn. bylaws apparently do not provide for the unique situation. An IATA spokesman in Montreal said the agency would have no comment pending a policy study.

Rusck had been under fire in the Scandinavian press since SAS's financial plight became known earlier this year (AW Feb. 13, p. 47; Mar. 20, p. 34). Crippled by costly route expansions and the purchase of new medium- and long-range jet equipment and the necessary support facilities, the airline lost approximately $16.8 million during its last fiscal year.

With prospects almost as bleak for the present year, SAS was forced to ask the three Scandinavian governments concerned for funds to double its basic capitalization, and the parliaments of Sweden, Denmark and Norway recently voted a total of $40.9 million for this purpose (AW June 26, p. 39).

In an effort to cut back on expenditures, the airline already has severed most of its connections with Guest Aerovias de Mexico, S. A. Monetary and equipment loans to Guest to help the Mexican carrier establish a mid-Atlantic route to Europe had proved to be a heavy financial drain on SAS.

bilateral agreements should be handled in the Senate.

Airlines opposed to the bill feel that bilateral agreements would get short shrift in the Senate because air transport issues would normally be overshadowed by more compelling foreign policy matters. In addition, a number of airlines are satisfied with the present formula of executive approval of bilateral agreements.

Sen. Shoeppel's proposed bill is designed to put a "check" on giving "foreign airlines traffic rights which are many times more valuable than those obtained for U. S. air carriers." In effect, the bill provides that before the CAB could issue a foreign air carrier permit, it would have to determine that the permit is authorized by the previous agreement or by a treaty ratified by the Senate.

In essence, Sen. Smathers, who headed a special Commerce subcommittee in 1957 on international air agreements, supports the Bermuda principles, calls them "a logical, reasonable compromise of two opposing philosophies" that "provided a sound basis on which the airlines of two countries could operate in an orderly, effective manner and offer efficient service to the public."

Sen. Smathers feels, however, that the U. S. has failed to enforce the application of these principles to the day-to-day operations of foreign carriers flying over routes granted by the U. S. In a recent Senate speech, he said: "The consequences of this failure to uphold the principles has been the steady, alarming decline in the position of the American international carriers."

On this point, Board Chairman Boyd is not entirely in agreement. He is on record as stating that the Bermuda principles "are subject to serious criticism today, and it is questionable in our minds whether we can hold on to these principles."

Sen. Smathers' interest in taking action against rate-cutting lies in the economic effect of air carriers, operating in the Latin American area at fares below International Air Transport Assn. levels, is having on U. S. flag carriers. He contends that the President has full authority to cancel the rights of these airlines to operate into points in the U. S.

However, the Board, in its own words, says its power in international rate-making "is limited to passing on whether the [IATA] agreements are consistent with the public interest and, on those grounds, to either approve them or disapprove them." It adds, "by contrast, virtually all foreign nations exercise direct control over the rates of their own air carriers as well as carriers of other nations whom they have licensed to operate to and from their territories, including U. S.-flag carriers."

CAB Merger Policy Clarification Anticipated in N.Y.-Florida Case

Washington—Clarification of the Civil Aeronautics Board's long-range policy on airline mergers and competition is anticipated in the Board's handling of Northeast Airlines' request for renewed authority to operate its East Coast routes to Florida.

The New York-Florida renewal case, originally scheduled to concern only the issue of Northeast's authority to serve the New York-Florida market, has been made considerably more complex by a Board decision to include the question of whether the airline should be merged with a stronger carrier (AW June 19, p. 39).

As an initial step in this direction, CAB has asked all trunk airlines for detailed traffic and revenue projections for 1963, based on the assumption of a merger with Northeast.

Airlines hoping to enter the Florida market have primarily taken the direct course of filing formal applications for new routes from Boston or New York to Florida and requesting that they be consolidated as part of the renewal case. Little interest in a merger possibility was expressed by any of the carriers with the exception of Pan American World Airways, which emphasized that any such union should be conditioned on permitting Pan American to transfer Northeast's local service and New England routes to a local service airline.

Route Competitors

Competitors of Northeast on the Florida routes made it clear that they intend to block any CAB approach that could lead to a merger for Northeast or renewal of its Florida authority, which they contend has diluted traffic and placed all three airlines serving the market in critical financial condition.

Their major line of attack will concern a detailed outline of the progress already made on a proposed merger between Trans World Airlines and Northeast, with particular emphasis on the current status of stock ownership between Northeast and the Atlas Corp., which controls the carrier, and on what optional stock benefits might be planned for officers of the two companies if a merger is contemplated.

Pan American, along with Pan American Grace Airways and Braniff Airways, justified its bid for the New York-Florida route on grounds of its importance in channeling traffic between New York and Latin America.

Renewing Northeast's authority or giving the route to another domestic carrier, Pan American said, would reduce the international support needed to conduct a profitable operation at a time when more effective competition is needed against foreign competition.

CAB "side-stepped" this idea when it granted the route to Northeast in 1956, and has since failed to realize any of the progress on which it based the approval, the airline said.

Panagra, which was a participant in the original New York-Florida route proceeding, also filed for a New York-Miami route to permit it to make maximum use of its schedule of 12 weekly flights to South America and eliminate its current interchange agreement with National Airlines between Miami and New York.

"Severe foreign competition" was also cited by Braniff as the major reason for applying for a New York-Washington-Miami route, which it now serves under an interchange agreement with Eastern Air Lines. Access to New York from Florida is "vital" the airline said in emphasizing its need for more long-haul markets.

Trans World Airlines filed a short application asking for a Boston-New York-Miami route, making no comment on issues to be considered under Northeast's renewal proceeding. Northwest Airlines also has asked for the Florida route. American, United and Delta have asked to intervene in the case.

Eastern and National presented the strongest oppositions to Northeast's bid for renewal, with Eastern concentrating on disclosure of all financial dealings concluded between Northeast and the Atlas Corp. Requesting such information as a stock option list showing the amount of unissued stock which may be held in reserve for the possible benefit of executives of either company, Eastern wants an exchange of exhibits by Aug. 11 and a hearing by Sept. 5.

In a similar request, National reminded CAB that the Board has already stated its concern about Northeast's financial condition and expressed a determination "to avoid, if possible, being confronted with another situation like United and Capital."

National suggested that the scope of the renewal case be enlarged and all issues clarified. The Board should also examine the possibility of suspending Northeast's permanent operating authority and dividing its New England routes, with the Boston-Montreal nonstop route shifted to Eastern, New York-Boston transferred to Allegheny and the remaining routes going to Mohawk Airlines.

Independents' Route Applications May Affect Trident Jet Orders

London—British European Airways, the state-owned airline, last week said that 16 of 24 de Havilland Trident jet transports now on order would become surplus if parallel routes were granted to the independent airlines.

Posing a general objection to 72 route applications before the Air Transport Licensing Board, BEA also warned that granting the routes would have severe repercussions in bilateral negotiations "in view of increasing protectionist and restrictive policies of European governments."

Spokesmen told the board that the Trident order was based on traffic projections to 1966 and that diversion of traffic from BEA to the independents would make most of the airplanes redundant.

Reference to the aircraft orders, although expected, pose a problem for the Licensing Board, because British United Airways, the largest independent, has ordered 10 BAC 111 short-haul twin jets (AW May 15, p. 42). These aircraft probably are contingent on British United obtaining a majority of its route applications.

In testimony before the board, Peter W. Brooks, BEA fleet planning manager, said that even if all Tridents were retained in the program, a larger number of older airplanes would have to be disposed of at a cost disadvantage.

In defense of BEA's pooling arrangements, under attack by the independents (AW June 26, p. 43), W. R. Collingwood, manager of commercial agreements, claimed that these pacts generated more traffic than would be normally allowed under bilaterals alone. The pools, he stressed, are renegotiated every summer and winter and result in a better spread of service, lower costs and less duplication.

He denied that pools eliminated competition, adding that "no airline can rely on such agreement to retain its competitive position." He predicted that if pool agreements were canceled, the result would be higher fares.

In another development involving independent airlines, the British Parliament passed the North Atlantic Shipping Bill allowing Cunard Steamship, Ltd., owner of Cunard Eagle Airways, a $25-million subsidy and loan to build a new Queen ocean liner.

The bill was attacked by the Labor opposition as, in effect, a subsidy to allow Cunard Eagle to buy two U.S. jets, Boeing 707-402s, to compete with stated-owned BOAC.

Request Denial

Washington—Civil Aeronautics Board has denied a Seaboard World Airlines application to carry passengers on a space-available basis on scheduled transatlantic cargo flights, but the airline plans to resubmit its application soon.

In its original application, Seaboard said it would conduct the proposed passenger service for an initial period of one year and added that the requested authority was vital to its existence and growth. It told the Board that the fleet of five Canadair CL-44 cargo turboprop transports which it has on order will increase capacity over 300%.

Denying the authority, the Board found that Seaboard had not made sufficient showing to warrant granting it.

"We have selected this course of action primarily because we are reluctant to proceed in a matter of this nature and significance without an appropriately filed application by the carrier seeking operating authority," the Board said.

It is this wording that has raised speculation that the Board will reconsider its decision if a revised application is filed.

FAA Assumes Control Over Tall Structures

Washington – Federal Aviation Agency will assume licensing control over tall structures that represent potential flight hazards in the U.S., despite objections from the Federal Communications Commission.

FAA's new regulation, effective July 15, will require persons interested in erecting certain structures to give the agency at least 30 days' notice. In general, structures more than 150-ft.-high that either extend into an airport's approach plane or are within 500 ft. of any runway fall in this category (AW Sept. 26, p. 40).

The new Part 626 of the Civil Air Regulations also contains six mathematical criteria which will enable builders to determine whether a particular structure might prove hazardous to air operations. For example, structures with a height of 500 ft. or structures with a height of 200 ft. built inside a control zone or within 5 mi. of a low-altitude airway centerline are considered potential hazards.

First proposed Sept. 16, the rule drew criticism from FCC, which contended that radio and television antennas should not be the subject of final FAA control.

But the rule as adopted will effectively require builders of broadcast towers to obtain permits from both FCC and FAA. At the same time, the new Part 626 provides for "antenna farm areas" where broadcast towers can be concentrated to minimize their intrusion into navigable airspace.

FAA's rule does not apply to structures already in existence. Alteration of these structures, however, must meet the new criteria. To handle individual cases where an exception might be called for, the rule outlines a procedure for holding "fact-finding" hearings.

Peruvian Line Charges Violation by Panagra

Washington – Aerolineas Peruanas, Peruvian privately-owned airline, has charged Panagra with violating the bilateral agreement between the U.S. and Peru and has asked the Civil Aeronautics Board to investigate.

The airline told the CAB last week that Panagra has been offering service in "gross excess" of the traffic moving between the U.S. and Peru. It added that Panagra's operations are largely geared to serve Fifth Freedom traffic and that the carrier is violating terms of the bilateral which require it to provide capacity that has as its "primary objective" the service of Third and Fourth Freedom traffic.

Aerolineas Peruanas added that while the U.S.-Peru air market is predominantly non-U.S. citizens, U.S. carriers have captured the bulk of the market. Panagra operates from its northern terminal point in Panama into the U.S. through interchange agreements with several U.S. carriers.

The Peruvian carrier asked CAB to institute a proceeding which would enforce the terms of the bilateral agreement with respect to Panagra's excessive capacity, modify Panagra's certificate to prevent future violations or suspend its certificate for non-compliance.

BOAC Is X-Raying Britannia Tail Units

London—British Overseas Airways Corp. is X-raying tail units of its 31 Bristol Britannia turboprop transports, after discovery of cracked elevator hinge brackets on a BOAC Britannia and another owned by El Al, the Israeli airline.

Tests are being made at London Airport, in conjunction with a Bristol Aircraft team, as the airplanes return from scheduled services. As of last week 10 airplanes had been inspected but only one fault was found. There were no cracks on three other El Al Britannias.

Crack was first noted on a BOAC Britannia during routine maintenance.

Fairchild Plans to Build Advanced F-27s

By David H. Hoffman

Hagerstown, Md.—Fairchild Stratos Corp. has designed two advanced versions of the F-27 twin turboprop transport in an effort to attract a second round of commercial orders—and its first military customer—by stretching the aircraft's range and boosting its maximum gross weight.

Despite the absence of any sales in 1960, a hard reappraisal of the F-27's potential market has resulted in a Fairchild decision to built eight new aircraft without waiting for prior orders.

Regardless of whether firm orders are received, the first advanced F-27 is scheduled to roll off the line here in September. The next three will follow at the rate of one per month beginning in October, with the balance falling due during the first half of 1962 if the company carries out its present plans.

Anticipating a Defense Department preference for U. S. engines, Fairchild is considering the General Electric T64-GE-8, partly developed with Navy funds, and the Lycoming T55-L-5 turboprops as substitute powerplants on later series F-27s. Neither engine has Federal Aviation Agency certification, however, and Fairchild feels that military use should precede commercial application. Rolls-Royce Dart turboprops now power all F-27s.

Three follow-on versions of the Fokker Friendship proposed by Fokker in Holland (AW Feb. 6, p. 45) are being developed independently and will have no immediate influence on Fairchild's planning. Should a market develop for Fokker's STOL, stretched-fuselage or high density version of the Friendship, however, Fairchild says that it will study the sales potential of similar aircraft in the U. S., then take advantage of Fokker's engineering progress.

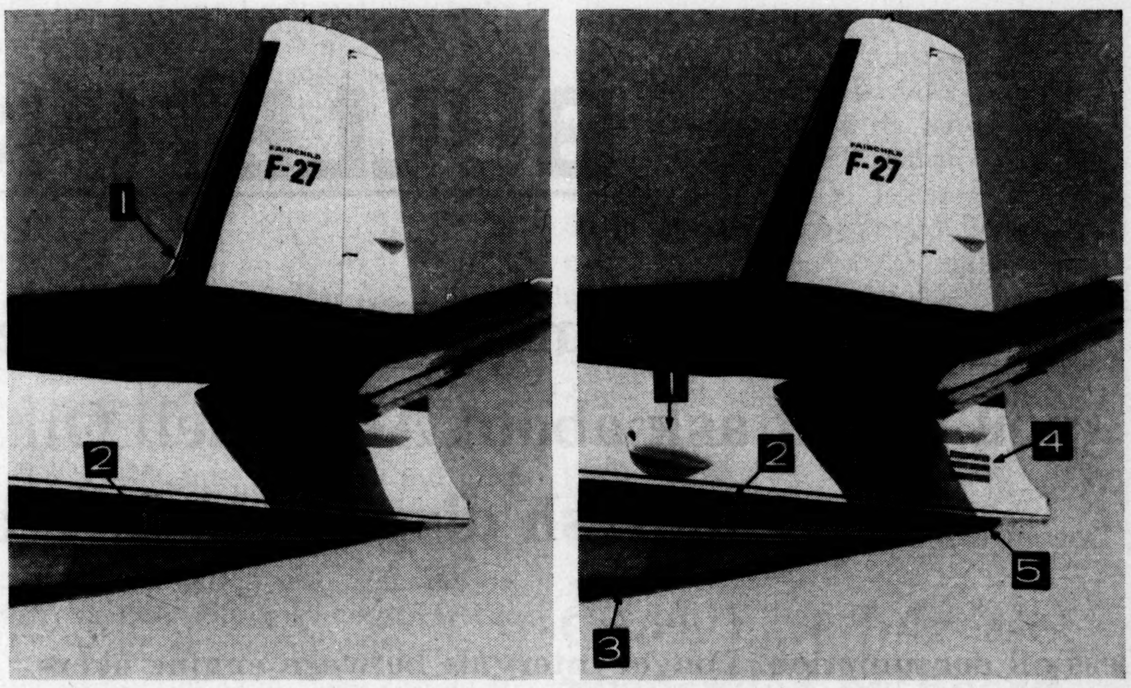
In a series of steps scheduled through late 1962, these follow-on versions of the F-27, all of which are to retain the transport's basic geometry, are to be made available:

- **F-27G utility freighter.** A 42,000 lb. gross weight aircraft—F-27s now in service can take off at only 38,500 lb. The F-27G will be offered with a choice of four fuel capacities: 1,336, 1,700, 1,920 or 2,090 usable gallons. It will incorporate a large forward cargo door for simultaneous troop and freight loading.
- **Longer range F-27F** executive-military transport. By March, 1962, Fairchild plans to obtain FAA certification of a 42,000-lb. gross weight F-27F with a fuel jettisoning system. Certification of a 39,400-lb. F-27F with a 37,500-lb. landing weight now is under way, with completion scheduled for October.

Except for landing roll checks, all test flights for the 39,400 lb. certification are being conducted with an aircraft weighing 42,000 lb. As a result, little extra work will be needed to obtain FAA approval of the heavier F-27.

All growth versions of the transport, including the eight aircraft being built on speculation, will incorporate Fairchild's F-27 aerodynamic cleanup, which centers on a new and streamlined air conditioning system. Primarily by replacing the transport's two externally mounted airscoops with a single flush inlet port on the leading edge of the vertical stabilizer, Fairchild estimates that it can increase F-27 airspeed by about 15 kt.

A second major improvement planned for new F-27s is a pressurization system designed to keep the aircraft's cabin at 8,000 ft. while the aircraft is cruising at 25,000 ft. To accomplish this, Fairchild increased cabin pressure differential from 4.16 to 5.4 psi. on the basis of tests conducted at the Fokker plant in Holland involving pressure differentials as high as 11.5 psi. To maintain a cabin pressure equivalent to 8,000 ft., current

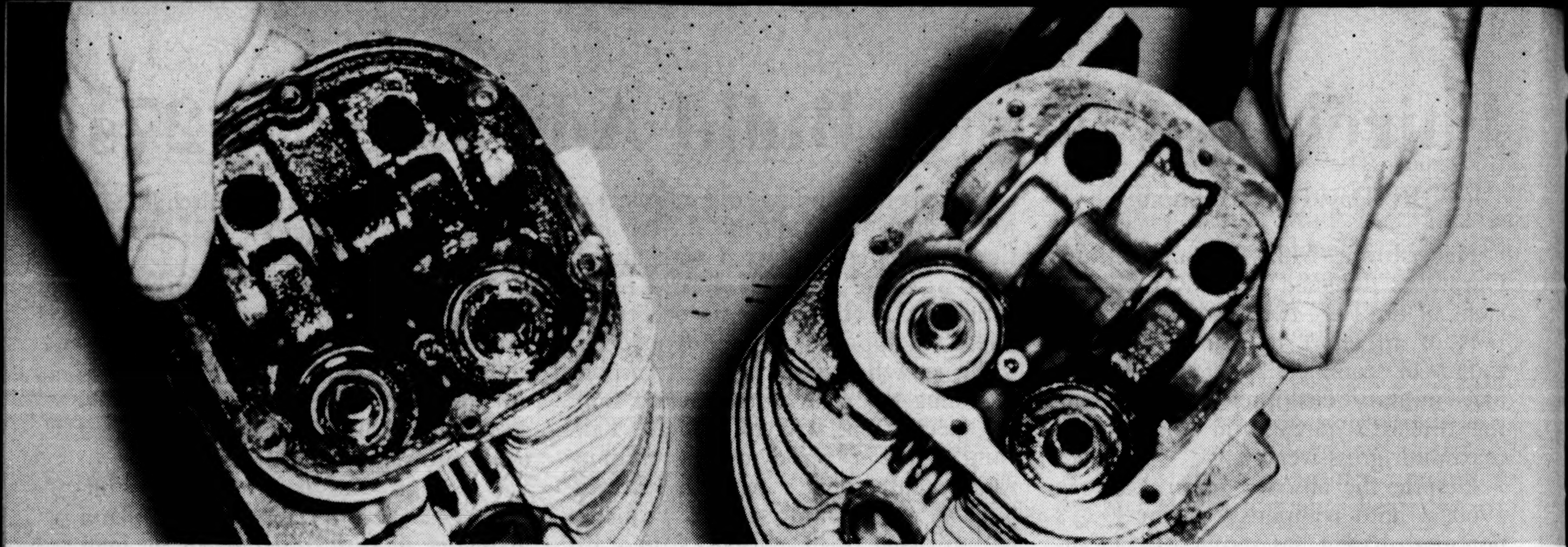


AERODYNAMIC CLEAN-UP program for the Fairchild F-27 is designed to increase the twin-turboprop aircraft's airspeed by about 15 kt. Advanced versions of the F-27F and all F-27G series aircraft (left) will have a single air inlet on the leading edge of the vertical stabilizer (1) and louvers on either side of the fuselage (2). Older models (right) have dual fuselage-mounted airscoops (1) and fuselage inlet and exit ports (3, 4 and 5) which are eliminated in the new configuration. Some external liquid drains also are eliminated.

F-27F Payload Range Capabilities

	Modification A	Modification B	Modification C
Takeoff weight (lb.)	39,400	39,400	42,000*
Landing weight (lb.)	37,500	37,500	37,500
Zero fuel weight (lb.)	36,300	36,300	36,300
Operating weight (lb) with 40 passenger seats	24,851	24,851	25,111
Maximum payload (lb.)	11,449	11,449	11,189
Range for maximum payload (naut. mi.)	300	310	780
Range for 8,000-lb. payload (40 passengers) (naut. mi.)	965	1,020	1,440
Payload lb. (passengers)			
for 1,600-naut.-mi. range	4,800 (24)	5,350 (26)	7,250 (36)
for 1,800-naut.-mi. range	3,850 (19)	4,450 (22)	6,300 (31)
for 2,000-naut.-mi. range	2,900 (14)	3,550 (17)	5,400 (27)
for 2,200-naut.-mi. range	1,650 (8)	2,650 (13)	4,500 (22)
for 2,400-naut.-mi. range		600 (3)	3,550 (17)
San Francisco to Honolulu	2,019 (10)	2,019 (10)	3,307 (16)
with headwind	10 kt.	26 kt.	36 kt.

* Incorporates fuel jettisoning system.



Dramatic proof of AeroShell Oil W stability. Rocker box section (left) ran for 250 hours using a good straight mineral oil. Rocker box (right) ran over twice as many hours on AeroShell Oil W. Note remarkable cleanliness.

BULLETIN:

Shell answers the ten questions you might ask about AeroShell Oil W—world's first non-ash dispersant aircraft oil

Less oil consumption. Longer intervals between engine overhauls. Easier starting, faster warm-up, reduced wear on piston rings, cylinder bores, cam lobes, lifter faces, gears and bushings.

All these benefits have been obtained with new AeroShell® Oil W. Here, in handy question-answer form, are the facts.

1. What types of aircraft can use AeroShell Oil W? Piston engine planes of any size. Helicopters, too.

2. Why is it called a non-ash dispersant oil? Because it contains special additives that help keep tiny, ingested particles in the oil from clumping together and forming deposits. These particles remain suspended and dispersed until they burn.

3. How does this effect engine performance? It means that engine parts stay cleaner. That lubrication points get all the oil they need. *Your engine runs more efficiently, parts last longer.*

4. What about oil consumption? Because AeroShell Oil W means decreased wear and a cleaner engine, you can expect less oil consumption.

5. Can AeroShell Oil W reduce my maintenance costs? If you have been using a straight mineral oil, AeroShell Oil W can reduce your maintenance costs substantially. Reason: your engine runs cleaner and cooler. Oil consumption is less. Thus, you can extend intervals between engine overhauls.

6. How does this new oil respond from a cold start? AeroShell Oil W has an unusually high viscosity index. This guards against excessive thickening of the oil when cold, yet provides outstanding lubrication when hot. Result: *easier starting, faster warm-up.*

7. Is AeroShell Oil W thoroughly proved? Thoroughly. It's had millions of engine hours of flight time.

8. Where is it available? At Shell Aviation Dealers everywhere. *Any* dealer will stock AeroShell Oil W if you ask for it.

9. Can I add AeroShell Oil W as a make-up oil? Yes. It is compatible with all piston engine oils now being used.

10. Is there more than one viscosity grade? What do I ask for? AeroShell Oil W is available in *three* viscosity grades: 80 grade for small engines where straight mineral oil grade 55, 65, or 80 is normally recommended. Also in 100 and 120 grades for large engines where straight mineral oil grade 100 or 120 is normally recommended.

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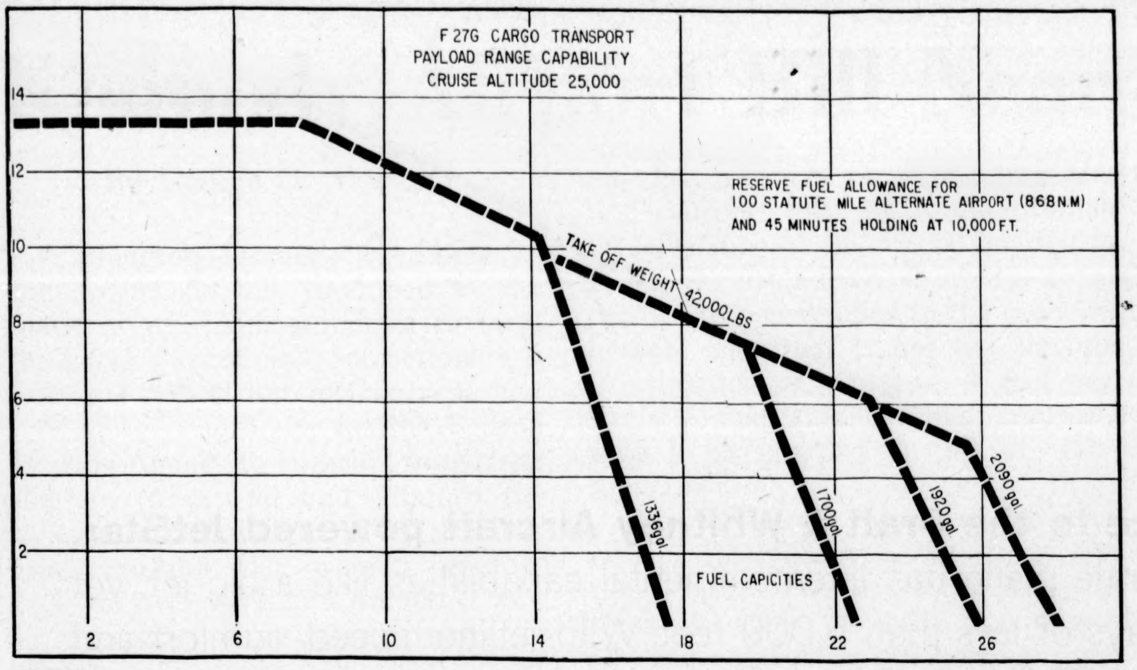

CHART shows payload versus range capability of various versions of the Fairchild F-27G cargo transport design. All carry 1,336 gal. of usable fuel in standard outboard wing tanks. The greater fuel capacities would be achieved by installing bladder tanks of variable sizes in the F-27's inboard wing section. Chart assumes aircraft with an operating weight from 23,140 lb. to 23,567 lb. and large forward cargo door. Climb to 25,000 ft. is at best climb speed with maximum recommended climb power. Long-range cruise speed at 25,000 ft. is based on optimum fuel consumption. The F-27G with 2,090 gal. of usable fuel can carry a 5,000 lb. payload 2,560 naut. mi., then hold 45 min. at 10,000 ft. and proceed to an alternate 86.8 naut. mi. away.

F-27s normally cannot fly above 20,000 ft.

Evolution of the F-27 from its present maximum gross of 38,500 lb. to 42,000 lb. will add only about 370 lb. to the aircraft's empty weight, according to Fairchild. As a result, almost all of the weight increase can be translated into extra fuel or, in many cases, extra payload. Fairchild also plans to market a conversion kit that will enable current operators of the F-27 to achieve the 39,400 lb. takeoff weight, the 37,500 lb. landing weight and the improved pressurization without returning their aircraft to the factory here.

Fairchild readily admits that its F-27 sales program was in a state of relative stagnation for more than a year. From Dec. 22, 1959, until the first of 1961, not a single transport was sold, and the manufacturer has yet to attract a military order despite the fact that the F-27 was designed primarily as a Douglas DC-3 replacement. During all of 1960, Fairchild had five F-27s plus a demonstrator in its hangars ready for almost immediate delivery but there were no customers.

After the company re-evaluated the market for F-27s and renewed its emphasis on sales late last year, however, these aircraft moved quickly. After all six were sold at the rate of one per month beginning in January, Fairchild was forced to buy back an F-27 from the Murray Corp. in order to carry out certification testing and design improvements. According to Fairchild, these 1961 sales brought in the highest rate of return of any F-27 sales to date. Largely because forthcoming aircraft will incorporate parts from the company inventory, the basic price of the airplane will remain at $830,000 during the near future, Fairchild told Aviation Week.

Navy (AW June 19, p. 29 and June 12, p. 50) and National Guard interest in a DC-3 replacement, an interest that could involve 200-300 aircraft, has led Fairchild to stress the F-27's merit as a utility transport capable of carrying both cargo and up to 50 troops in bucket seats or 40 passengers in track-mounted seats. In a specially prepared brochure aimed at selling the aircraft to the National Guard, Fairchild claims that the F-27 is "ideally suited" to the Guard's needs.

Aloha Refuses to Use Honolulu Terminal

Honolulu—Aloha Airlines is refusing to move into Honolulu's new $740,000 Inter-Island Air Terminal unless the Hawaiian Aeronautics Commission builds a 36-ft. addition to its portion of the new terminal.

Hawaiian Airlines, Aloha's competitor for inter-island traffic, was the only airline occupying the new terminal when it was formally dedicated last month.

Meanwhile, Aloha appears satisfied to stay in the old International Airport across the field from the new inter-island terminal—with the advantage of being closer to interline connections.

Aloha, which specified its section of the new terminal when the carrier was deriving a smaller share of the inter-island traffic, has space about half the size of Hawaiian's in the new airline building.

Before the 36-ft. extension can be built, the Hawaii attorney-general must rule whether money from a $14-million 1959 Hawaiian aviation bond issue can be used for expansion of Aloha's facilities before all objectives of the bond issue have been met.

The bondholders' representative says it cannot.

The Hawaiian Aeronautics Commission says that unless the attorney-general approves the $45,000 construction, the money will have to be raised elsewhere.

Rotodyne Helicopters Planned for Caribbean

Indies Air, Inc., a new organization which has filed for routes in Puerto Rico and the Virgin Islands, has signed a letter of intent with Kaman Helicopter to buy five Rotodyne VTOLs. Kaman is the U.S. licensee for the 50-60 passenger compound helicopter, under development by Westland Aircraft, Ltd., of England.

Delivery target is 1965. The aircraft would be used for intra-Puerto Rico routes and routes to the Virgin Islands from Puerto Rico. Indies Air's initial plans call for service to the U.S. Virgin Islands of St. Thomas and St. Croix as well as the intra-Puerto Rico service.

Coach Fare Increase Suspended by Board

Washington—Civil Aeronautics Board has suspended Braniff Airways' plan to increase its day coach fare from 75% to 85% of the first-class fare, an increase designed to discourage diversion of passengers from first-class to coach travel.

The suspension until Sept. 28 will give the Board a chance to investigate the proposal, which was scheduled to go into effect between certain cities July 1. Braniff scheduled the fare increase after deciding that present coach fares are causing diversion from its first-class traffic.

The carrier said that the present value of service received for a coach fare is too similar to first-class service to warrant the current 25% differential from first-class rates. Braniff maintains that the main difference between first-class and coach service is the size and spacing of seating and the elaborateness of meals.

The Board noted, however, that this seating differential is "the primary distinction" on which the 25% coach fare differential was originally based. It suggested that Braniff consider adjustment of seating capacity as a possible solution to declining first-class loads.

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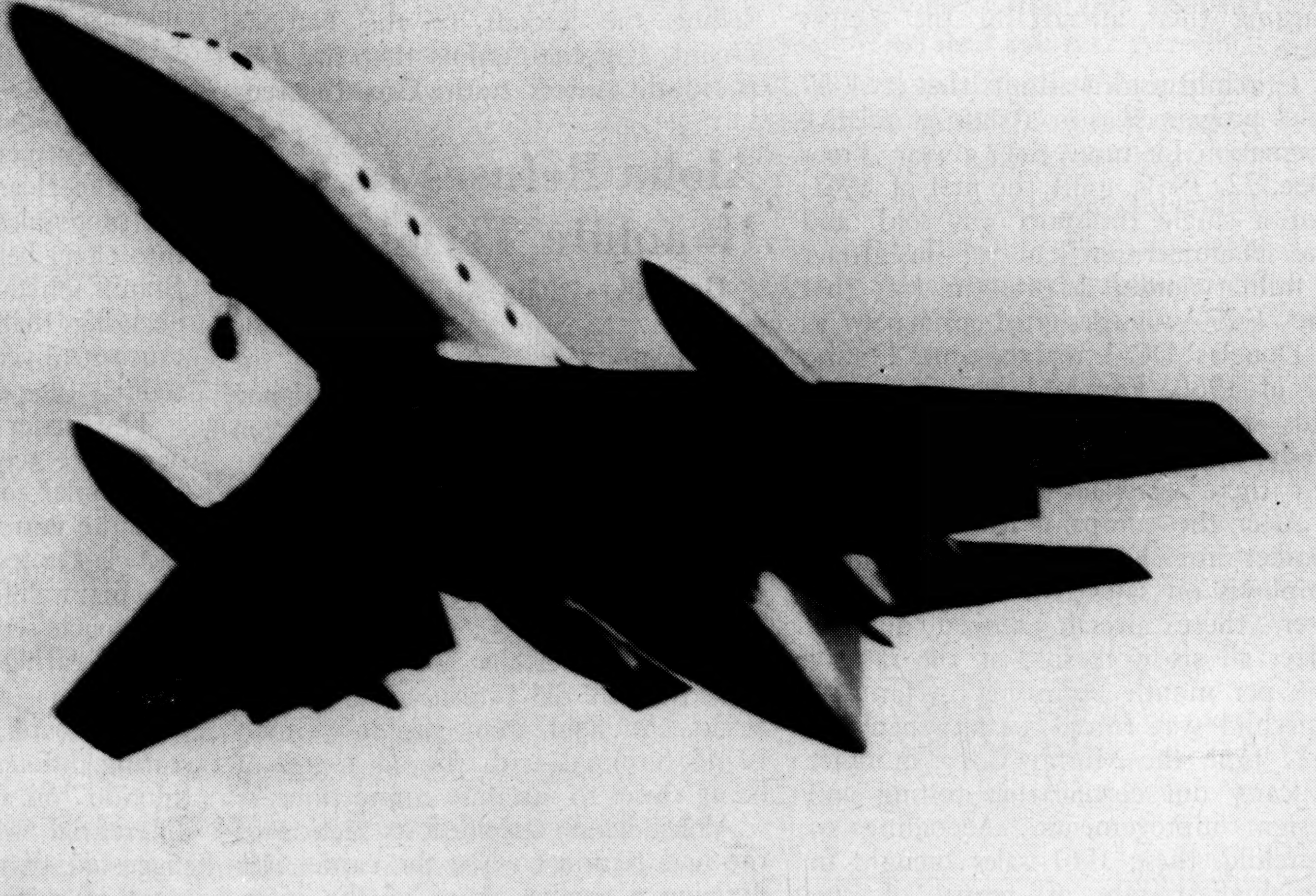

Kennedy Airport Bill Nears Critical Test

By George C. Wilson

Washington—Kennedy Administration airport aid bill, revamped by the House aviation subcommittee to meet "backdoor spending" objections, is nearing a critical test in Congress.

At stake is authority for the Federal Aviation Agency to launch a long-range program to expand and improve the national airport system. The Kennedy Administration bill would authorize FAA to give cities $75 million a year for five years in matching funds for airports.

Fiscal conservatives in the House, already mobilizing for their floor fight against the President's bill to authorize a five-year foreign aid program, do not like the long-range approach in the airport measure. They see it as an attempt to bypass the congressional appropriations committees. They also fear that approving the airport aid bill would weaken their fight against the same type of long-range approach to foreign aid.

Their main objection—especially among conservatives on the House Appropriations Committee—is the contract authority in the Kennedy Administration airport bill. This obligates the government to give a community the funds specified once a contract for airport money is signed. If the congressional appropriations committees refused to appropriate the money, the FAA, under the contract authority, could get the funds directly from the Treasury—the so-called "backdoor" approach.

Halaby Urges Approval

FAA Administrator Najeeb E. Halaby, urging Congress to approve the contract authority, said "legislation surely providing for funds over a period of years is absolutely essential if we are to achieve a safe and adequate national system of airports."

He cited figures showing that communities spent much more on airports when the federal aid program was on a long-range rather than a yearly appropriation basis. Local authorities "insist that there be some basis on which to proceed within their own community to develop the public understanding and support for spending money on airports," Halaby said.

But Chairman John Bell Williams (D.-Miss.) of the House Transportation Aeronautics Subcommittee, conceding that long-range contract authority might be more efficient, counters that Congress is responsible for handling the nation's money.

"Undoubtedly," he told Halaby during the hearings on the Administration's airport bill, "it would promote the efficiency of this operation if Congress just surrendered all of the appropriative responsibilities to the executive branch. But that is not the way the Constitution is written. I feel very strongly that this backdoor approach should be stopped in all of these agencies."

Rep. William L. Springer of Illinois, ranking Republican on the House aviation subcommittee, told Aviation Week he agrees with this view despite all the testimony supporting long-range contract authority. The backdoor spending issue was the principal reason why the Administration's airport bill was delayed from May 12 when the hearings ended until June 29 when a drastically revised measure was sent to the parent House Interstate and Foreign Commerce Committee.

Rep. Williams described the revised bill as a compromise. It authorizes the FAA to spend whatever is appropriated in the five fiscal years from 1962 to 1966. But the House Appropriations Committee could not be circumvented under this version. If it did not appropriate money for airports, the FAA could not go to the Treasury for funds.

Chairman Albert Thomas (D.-Tex.) of the House Appropriations Independent Offices Subcommittee, which would handle the airport appropriations, reportedly is enlisting support for the compromise version by offering to appropriate enough money in Fiscal 1962 to last two or three years. But by accepting such conditions President Kennedy runs the risk of weakening the argument for the long-range authority he feels is crucial to his foreign aid program. So the President is expected to exert heavy pressure to keep his airport bill intact.

Short-Range Competition

New York—Prospective market for short-range jet transports, now estimated at several hundred, has kicked off a flurry of serious airframe and engine studies in the United States aimed at beating out the British Aircraft Corp.'s BAC 111 (AW May 15, p. 42).

Major requirement is to get a short-range, medium-capacity transport that can make money for the operator over 200-mi. stage lengths, and that would have an operating cost of about one dollar per airplane mile.

At least five airframe manufacturers are developing designs in the 60,000- to 80,000-lb. weight class to meet these requirements. Boeing's proposal is called the 737, Douglas has designated its the Model 2086 and McDonnell is working on the T85A. Lockheed and Convair are also known to have design teams working on this requirement.

Powerplants most probably would be a pair of high bypass-ratio turbojets rated at approximately 12,000 lb. sea-level static thrust. "Paper" engines have been developed also around this requirement.

The House subcommittee's airport bill is scheduled to go before the Interstate and Foreign Commerce Committee this week. This will provide a crucial test of the President's strength on the backdoor spending issue. Another crucial test for the airport bill will come soon on the House floor itself.

Monroney Supports Kennedy

Chairman A. S. Mike Monroney (D.-Okla.) of the Senate aviation subcommittee told Aviation Week the bill reported by the House aviation subcommittee represents a "heavy blow" to hopes for a long-range airport program.

He originally planned to wait for the House to pass its airport bill, hoping the Senate could accept the measure and avoid a conference on differences. But Sen. Monroney said he now will prepare the Administration's version for consideration by the parent Senate Commerce Committee. He believes the Kennedy Administration airport bill will pass the Senate easily.

The threat to the airport bill from the backdoor spending argument contrasts sharply with the hopes its backers had after President Kennedy's election. They felt that with the threat of former President Eisenhower's veto lifted, a long-range bill would pass through Congress easily.

President Eisenhower vetoed an airport bill in 1958 providing $100 million a year for five years. In his Jan. 19, 1959, budget message, he settled any lingering hopes for presidential support of a sizable airport bill by calling for "an orderly withdrawal from the program by 1964." As a result of this attitude, the Senate that year trimmed the Democratic bill calling for a five-year, $575-million program to a four-year plan for $465 million. The House cut the program down to $297 million. The Senate and House finally settled for a simple two-year extension of the then existing airport program at $63 million annually.

The Kennedy Administration bill represents a revival of the Democratic recommendations made while President Eisenhower was in the White House. But there are several new features, including $7 million a year for general

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aviation airports not used by the scheduled airliners. The argument for this type of federal aid is that the expansion of general aviation airports will relieve congestion at the major fields now handling mixed traffic.

Another innovation in the Administration bill is authority for FAA to deny federal money for an airport which does not have landing aids "required for the safe and efficient use by aircraft of the airport." This specific power would strengthen FAA's hand in dealing with airport officials.

These are the major fiscal provisions in the Kennedy Administration airport bill:

- **States would receive** $49,875,000 a year for Fiscal 1962 through 1966 under the population-area formula in the present Federal Airport Act. The annual amounts would range from $3,994,844 for Alaska to $78,332 for Delaware. If by the end of a fiscal year a state did not sign a contract with the federal government for its share of the airport money, the amount not obligated would go into a special fund handled by the FAA administrator. They have two years under the present legislation.
- **Discretionary fund** would total $16,625,000—25% of the $75-million annual total—in each of the five fiscal years.
- **FAA could assign** $7 million a year for building and improving airports, "the primary purpose of which is to serve general aviation and to relieve congestion at airports having high density of traffic serving other segments of aviation." These funds would not have a deadline for use.
- **Puerto Rico** would receive $975,000 a year, and $525,000 a year would go to the Virgin Islands.

The states would have to match the federal contribution dollar-for-dollar on such physical improvements as new runways. But they would have to provide only 25% of the funds for landing aids, such as approach lights and runway distance markers. No federal money could go for airport parking lots or facilities such as cocktail lounges.

The current airport act, authorizing $63 million a year, expired July 1. President Kennedy, in asking Congress Apr. 24 for new legislation, said "continuing the program of federal assistance to airports is essential to our national security, passenger safety and economic growth." The Airport Operators Council, American Assn. of Airport Executives and National Assn. of State Aviation Officials said their joint survey of airport needs conducted last fall disclosed that in the four years from July 1, 1961, to June 30, 1965, the 50 states need $532.6 million more for airports than they can raise. (See box.)

State Airport Financing Needs

July 1, 1961 to June 30, 1965

States:	Publicly-Owned Airports	Airports Reporting Projects Planned	Cost of Projects Planned	Funds Available and Anticipated From Local and State Sources	Additional Funds Needed
Alabama	53	3	$4,540,000	$2,105,150	$2,434,850
Alaska	256	118	27,594,500	11,174,750	16,419,750
Arizona	101	22	24,882,823	14,814,248	10,068,575
Arkansas	55	10	1,224,400	723,200	501,200
California	213	64	122,739,771	77,344,653	45,395,118
Colorado	58	8	18,959,723	11,821,307	7,138,416
Connecticut	7	12	18,345,400	9,791,750	8,553,650
Delaware	3	1	730,400	338,000	392,400
Florida	95	30	85,443,944	28,941,441	56,502,503
Georgia	52	7	59,150,600	29,754,600	29,396,000
Hawaii	13	8	25,197,200	12,598,600	12,598,600
Idaho	135	15	2,558,777	1,412,633	1,146,144
Illinois	56	58	47,363,600	20,371,300	26,992,300
Indiana	105	17	8,667,295	4,454,215	4,213,080
Iowa	83	22	10,547,677	6,009,177	4,538,500
Kansas	99	10	5,446,800	1,197,950	4,248,850
Kentucky	31	38	30,356,725	16,600,375	13,756,350
Louisiana	41	10	28,172,400	14,149,700	14,022,700
Maine	29	19	6,245,319	3,513,744	2,731,575
Maryland	11	8	19,360,100	10,425,121	8,934,979
Massachusetts	24	40	38,024,400	22,283,950	15,740,450
Michigan	125	90	84,629,646	53,835,848	30,793,798
Minnesota	103	51	14,472,510	9,134,391	5,338,119
Mississippi	44	63	13,843,600	7,151,000	6,692,600
Missouri	81	8	1,732,225	891,600	840,625
Montana	103	57	8,694,750	6,260,937	2,433,813
Nebraska	96	29	7,987,998	5,494,546	2,493,452
Nevada	15	5	8,049,080	6,197,290	1,851,790
New Hampshire	16	8	2,514,314	1,296,250	1,218,064
New Jersey	30	2	40,580,000	25,849,250	14,730,750
New Mexico	36	8	5,881,300	693,524	5,187,776
New York	46	17	88,432,550	42,904,695	45,527,855
North Carolina	59	3	5,280,700	2,669,000	2,611,700
North Dakota	112	27	4,853,400	2,745,600	2,107,800
Ohio	182	10	24,501,650	11,672,300	12,829,350
Oklahoma	74	9	13,967,000	7,744,186	6,222,814
Oregon	90	12	4,584,682	2,560,205	2,024,477
Pennsylvania	165	26	37,526,555	25,843,853	11,682,702
Rhode Island	5	5	5,813,470	3,257,720	2,555,750
South Carolina	55	20	17,982,420	7,716,000	10,266,420
South Dakota	57	28	4,244,995	2,173,295	2,071,700
Tennessee	63	62	37,577,673	21,454,500	16,123,173
Texas	227	113	49,722,784	12,379,061	37,343,723
Utah	46	40	4,352,522	900,450	3,452,072
Vermont	20	22	3,199,000	1,600,500	1,598,500
Virginia	31	11	5,153,607	2,626,000	2,527,607
Washington	80	10	13,852,400	7,312,818	6,539,582
West Virginia	42	8	6,403,300	3,545,066	2,858,234
Wisconsin	72	43	13,124,900	6,984,675	6,140,225
Wyoming	36	31	1,898,550	1,027,300	871,250
Total All States	**3,631**	**1,338**	**$1,116,409,435**	**$583,747,724**	**$532,661,711**
Ter. Puerto Rico	**15**	**21**	**8,635,000**	**4,317,500**	**4,317,500**
U. S. Total	**3,646**	**1,361**	**$1,125,044,435**	**$588,065,224**	**$536,979,211**

Source: Survey by Airport Operators Council, American Assn. of Airport Executives and National Assn. of State Aviation Officials.

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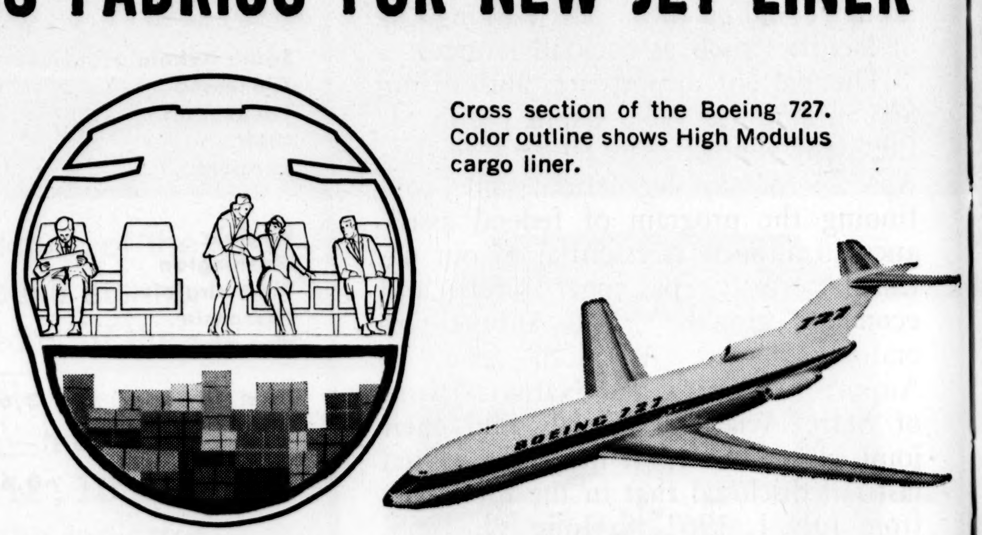

Cross section of the Boeing 727.
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SHORTLINES

▶ **Aeroflot** has replaced its Li-2 and Il-14 aircraft with the ski-equipped, 60-ton An-10A turboprop transport on polar air routes because the smaller aircraft were unable to carry the required heavy loads.

▶ **American Airlines** reports 4.5 removals per 1,000 hr. of flying time for the International Telephone and Telegraph-Federal Laboratories distance measuring equipment aboard its jet fleet.

▶ **American Airlines** will provide 17 coach and 54 first-class seats on its Electra turboprop aircraft after July 17. American's Electras currently have 68 first class seats.

▶ **Braniff Airways'** night coach family fare plan has Civil Aeronautics Board approval for a six-month trial. Under the family plan, the head of a family purchases one full night coach fare, and his wife and all children under 21 yr. travel at 50% of the night coach fare. Children from two to 12 yr. old fly at 25% of the fare.

▶ **Civil Aeronautics Board** will use a 95-passenger minimum as a basis for future charter exemption applications for L-1049E Super Constellation aircraft although the aircraft normally carries 92 passengers.

▶ **Bolivia** has asked for bids on the construction of a new international airport at El Alto, a suburb of La Paz.

▶ **Continental Airlines** is operating 6.25 million seat miles daily this summer—1 million more than last year's peak capacity.

▶ **Eastern Air Lines** reports a 53% increase in revenue and a 40% increase in poundage for freight carried during May over the same month last year.

▶ **Federal Aviation Agency** has asked small business firms to submit bids by July 13 for construction of an air mail facility building, a fire-crash equipment and personnel building, and a vehicle maintenance building for servicing mobile lounges and other airport vehicles at Dulles International Airport near Washington, D. C.

▶ **Lufthansa German Airlines** has opened a ticket office in Denver's Albany Hotel as part of Lufthansa's expansion program in the West.

▶ **Northwest Airlines** has begun service with Boeing 720B jet transports between Minneapolis-St. Paul and Chicago, and between Minneapolis-St. Paul and New York via Milwaukee. Initial schedules call for one round-trip flight daily between each pair of cities.

AIRLINE OBSERVER

▶ **One current concept of supersonic transport design is aimed at efficient cruise regimes in both supersonic and subsonic flight. Belief that the sonic boom may rule out continuous high supersonic cruise has led to this concept. At least one engine manufacturer thinks that powerplants can be made adaptable enough to give economical operation in both flight speed ranges.**

▶ Competitive battle between Aloha and Hawaiian Airlines has evolved into a public debate over the merits of high-wing or low-wing aircraft. Aloha's newspaper advertisements have been stressing the unobstructed view possible from each window in the high-wing design. Hawaiian is countering with an advertisement, which in at least one case ran simultaneously with the Aloha advertisement, that emphasizes the safety factor of low-wing aircraft in over-water flights. The Hawaiian sales pitch reads in part that "only Hawaiian flies low-wing Super Convairs for dependability over island waters, preferred by overseas carriers throughout the world. The cabin's above the wing."

▶ **Lear, Inc. and Sud Aviation have signed an agreement to develop a completely automatic landing system for the Caravelle turbojet transport. The system will utilize ground signals that will be fed by a landing computer into the autopilot.**

▶ United Air Lines is studying possibilities of installing arresting gear for its Boeing 727 medium-range transports. United's specification to Boeing calls for extra structural strength in areas likely to bear the brunt of arrested landing loads. Device under consideration will be similar to an aircraft carrier cross-deck pennant, but chances are that the wire would be caught by the landing gear rather than by a tail-hook. Landing gear would require less structural strengthening to cope with arresting load than would fuselage structure to handle a tail-hook, so the weight penalty would be less.

▶ **Early traffic indications point to a remarkable comeback for the Lockheed Electra turboprop transport since undergoing wing and engine nacelle modifications. Most carriers report high load factors on Electras operating over major routes.**

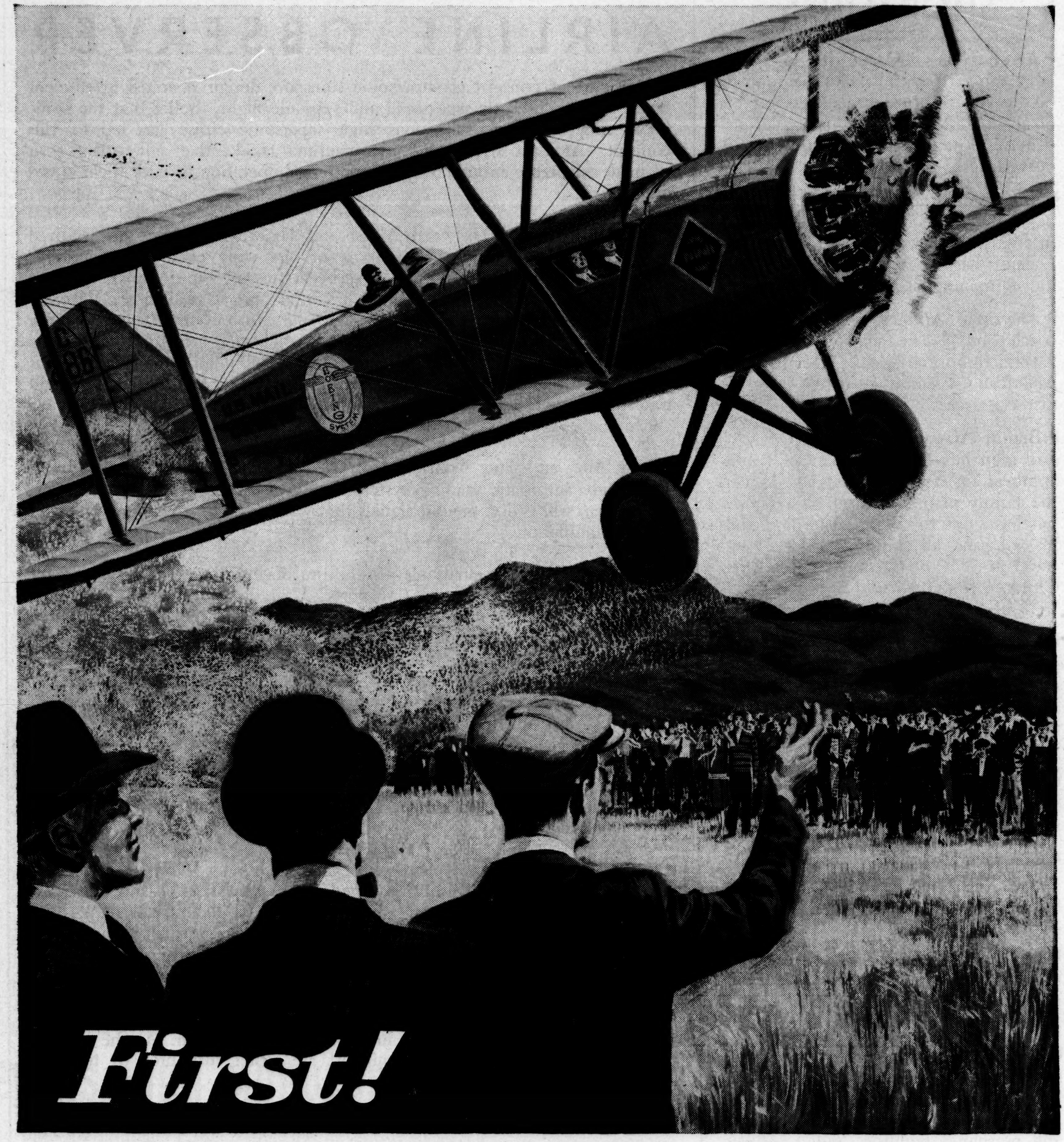
▶ Federal Aviation Agency has commissioned a Doppler VOR at Marquette, Mich. and will commission a second unit at Rikers Island near La Guardia Field, New York, about the first of August. Doppler VOR permits the location of a VOR unit in areas where obstructions such as buildings, gas tanks or bridges—as in the case of Rikers Island—would render a standard VOR inefficient.

▶ **Aeroflot will double the size of its aircraft fleet by 1965, and approximately 65 new Russian airports will be in full operation by then. At the present time, 200 of the airline's 2,000 aircraft are either turboprop or turbojet powered.**

▶ Three Brazilian carriers—Panair do Brasil, Real and Varig—will pool equipment on international routes to reduce operating costs. The economy measure was recommended by Brazil's President Janio Quadros.

▶ **Air Line Pilots Assn. has protested a Civil Aeronautics Board decision denying the union's request to intervene in the temporary mail rate proceeding for Southern Airways. ALPA President C. N. Sayen charged that the federal government has continued to subsidize Southern without attempting to investigate to determine whether the airline's management is meeting standards of "honesty, efficiency and economy."**

▶ Japanese bid for an around-the-world route for Japan Air Lines received a setback last week with State Department refusal to grant the carrier a New York-Europe route. U. S. will consider extending Japan Air Lines' Pacific route from the West Coast to New York but is withholding rights beyond because of the large number of carriers already serving the North Atlantic. Negotiations were recessed June 30 without fixing a date for resumption.



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Airline Traffic—April, 1961

	Revenue Passengers	Revenue Passenger Miles (000)	Passenger Load Factor %	U. S. Mail Ton-Miles	Express Ton-Miles	Freight Ton-Miles	Total Revenue Ton-Miles	Over-all Revenue Load Factor %
DOMESTIC TRUNKS								
American	629,739	491,427	63.1	2,028,274	892,788	8,916,893	58,956,524	55.8
Braniff	185,772	85,399	59.2	399,225	153,621	785,823	9,525,565	48.2
Capital	280,486	122,625	54.1	566,131	276,233	472,149	13,068,038	49.3
Continental	110,840	70,845	46.9	219,336	104,577	582,733	7,705,722	38.4
Delta	326,422	192,869	64.7	584,118	277,615	1,290,898	20,688,293	53.8
Eastern	691,862	372,504	55.2	1,387,284	545,308	2,082,569	39,819,121	43.8
National[1]	....	....	....	....	....	....	....	....
Northeast	158,594	76,924	54.4	158,972	49,377	262,498	7,837,836	44.3
Northwest	67,391	49,223	53.4	288,878	80,421	640,597	5,724,887	49.6
Trans World	394,229	338,143	58.5	1,491,464	693,232	4,127,743	38,745,794	47.8
United	678,483	478,297	60.9	3,685,128	1,003,837	7,280,005	57,814,897	51.9
Western	86,455	50,816	54.5	167,344	72,513	234,705	5,340,949	43.5
INTERNATIONAL								
American	7,411	8,222	57.5	9,259	1,320	295,127	1,160,808	48.9
Braniff	6,712	10,324	41.8	57,377	....	111,321	1,262,190	37.1
Caribbean Atlantic	40,600	2,802	68.4	2,008	....	8,436	273,230	67.1
Delta	1,332	1,739	37.7	1,012	....	13,929	202,222	34.5
Eastern	47,259	70,724	63.9	164,616	....	422,040	7,168,795	63.4
Mackey	15,166	2,480	51.1	....	190	8,688	252,053	50.6
National[2]	....	....	....	....	....	....	....	....
Northwest	10,632	19,921	41.8	1,556,092	1,418	518,054	4,214,072	64.0
Pan American								
Alaska	4,157	4,336	42.1	34,442	2,559	158,794	649,556	44.8
Atlantic	131,157	163,086	49.5	2,548,443	....	6,201,468	25,746,881	47.6
Latin America	84,769	106,161	59.9	441,819	....	3,685,711	14,893,121	59.7
Pacific	42,993	171,016	72.2	3,961,387	12,288	3,592,823	25,178,547	63.5
Panagra	10,405	18,183	59.2	98,084	....	626,915	2,684,490	58.7
Resort[1]	....	....	....	....	....	....	....	....
South Pacific	317	869	61.4	1,146	....	2,147	92,263	56.0
Trans Caribbean[1]	....	....	....	....	....	....	....	....
Trans World	21,015	60,847	42.5	1,517,694	....	2,759,579	10,639,726	46.9
United	12,135	30,261	67.7	320,671	8,195	152,082	3,586,558	58.5
Western	2,311	3,594	60.1	7,448	....	33,055	409,567	57.9
LOCAL SERVICE								
Allegheny	67,897	14,251	45.9	20,163	31,182	56,938	1,469,081	48.8
Bonanza	26,008	6,520	49.5	7,789	2,391	15,751	651,767	50.9
Central	19,321	3,733	31.1	13,418	7,037	18,310	396,429	29.7
Frontier[1]	....	....	....	....	....	....	....	....
Lake Central	31,971	3,103	34.3	8,738	21,144	10,802	528,387	35.5
Mohawk	58,592	11,637	46.8	8,378	21,924	21,543	1,177,393	44.1
North Central	78,292	13,955	41.8	44,889	43,550	56,238	1,484,705	42.9
Ozark	47,014	8,403	44.5	21,247	24,385	31,305	869,698	44.5
Pacific[1]	....	....	....	....	....	....	....	....
Piedmont	42,877	8,986	45.8	13,547	13,529	20,450	980,727	46.9
Southern	32,210	5,793	34.3	22,291	11,766	18,307	608,082	35.9
Trans-Texas	27,043	6,286	39.6	21,333	11,778	36,216	671,763	40.5
West Coast	30,105	7,307	41.0	15,177	4,681	19,409	737,150	41.4
HAWAIIAN								
Aloha	25,682	3,739	62.2	2,611	....	4,704	306,894	52.7
Hawaiian	36,281	5,281	59.5	4,158	....	128,528	556,805	58.4
CARGO LINES								
AAXICO[3]	....	....	....	....	....	....	....	....
Aerovias Sud Americana	....	....	....	....	....	198,376	198,376	61.9
Flying Tiger	2,318	12,293	68.5	36,830	35,739	10,603,996	11,905,854	77.9
Riddle[1] **— Domestic**	....	....	....	....	....	....	....	....
Overseas	....	....	....	....	....	....	....	....
Seaboard World[1]	....	....	....	....	....	....	....	....
Slick	1,887	11,559	97.4	....	....	2,309,449	3,464,494	94.2
HELICOPTER LINES								
Chicago Helicopter	20,728	346	38.3	1,127	....	....	34,157	32.2
Los Angeles Airways	3,649	136	54.8	5,267	2,391	....	20,690	61.7
New York Airways	13,488	285	58.4	1,605	907	527	30,331	56.9
ALASKA LINES								
Alaska Airlines	8,363	7,662	51.5	65,131	2,677	395,844	1,237,317	62.4
Alaska Coastal	3,675	396	54.9	3,907	....	5,809	50,071	64.2
Cordova	1,531	282	52.6	4,474	....	40,857	74,799	59.2
Ellis	4,510	308	52.3	1,923	....	2,961	36,377	61.8
Kodiak	675	36	36.5	372	....	643	4,671	34.3
Northern Consolidated	1,788	555	31.2	65,514	....	60,235	186,692	57.1
Pacific Northern	8,300	7,436	39.4	159,508	11,239	401,195	1,380,993	57.4
Reeve Aleutian	988	1,037	39.1	54,857	....	78,241	244,397	58.3
Western Alaska[1]	....	....	....	....	....	....	....	....
Wien Alaska	2,220	571	33.9	48,060	....	117,894	224,738	51.1
Avalon	5,159	307	48.8	547	....	288	30,052	50.2
Samoan[1]	....	....	....	....	....	....	....	....

[1] Not available. [2] National has suspended service to Havana, its only international route. [3] Operations suspended.

Compiled by AVIATION WEEK from airline reports to the Civil Aeronautics Board.

Cargo and Local Service Airlines List Officer, Director Salaries

Washington—Following is a list of airline officers' salaries, bonuses and indirect compensation, expenses, and stockholdings for the year ending Dec. 31, 1960, as filed with the CAB.

Southern Airways—F. W. Hulse, president and director, $25,000 salary, 34,019 shares of common stock, 2,000 shares of common stock in the name of others, $5,268 expenses; **G. Hall**, vice president-sales, $18,000 salary, no stock, $3,816 expenses; **W. S. Magill**, vice president-operations, $19,292 salary, 800 shares of common stock, $827 expenses; **G. F. Estey**, secretary and treasurer, $12,185 salary, 1,521 shares of common stock, $500 expenses; **C. H. D. Tarrer**, assistant treasurer, $11,737 salary, 325 shares of common stock, $2,690 expenses; **C. A. Beasley**, assistant secretary and director, $3,300 salary, 3,500 shares of common stock; $141 expenses; **W. B. White, Jr.**, assistant secretary and director, no salary, 932 shares of common stock $194 expenses; **G. F. Attwood**, assistant vice president (since April, 1960), $9,052 salary, 25 shares of common stock, $2,255 expenses; **J. K. Courtenay**, assistant vice president (since April, 1960), $8,793 salary, no stock, $788 expenses; **G. M. Gross**, assistant vice president (since April, 1960), $11,250 salary, 100 shares of common stock, $29 expenses; **W. B. Grubb**, assistant vice president (since April, 1960), $17,619 salary, no stock, $285 expenses; **I. Allen, Jr.**, director, no salary, 3,766⅔ shares common stock, 500 shares of common stock in the name of others, $100 expenses; **I. F. Jones**, vice president, no salary, 2,167 shares of common stock; **J. M. Atkins**, director, no salary, 220 shares of common stock, $50 expenses; **A. J. Brunini**, director, no salary, 2,600 shares of common stock, $131 expenses; **R. E. Orr**, director, no salary, no stock, 1,000 shares of common stock in the name of others; **F. D. Schas**, director, no salary, no stock, $106 expenses; **E. U. Beneke**, director, no salary, no stock, 1,000 shares of common stock in the name of others, $50 expenses; **H. P. Johnston**, director, no salary, 2,500 shares of common stock, $50 expenses; **G. G. Jordan**, director, no salary, 500 shares of common stock, 1,666⅔ shares of common stock in the name of others, $100 expenses; **W. H. Smith**, director, no salary, 500 shares of common stock, $50 expenses; **E. B. Stephens**, director, no salary, 1,495 shares of common stock; **R. H. Wooton**, director, no salary, 6,200 shares of common, $50 expenses; **A. F. Irby**, director, no salary, 3,300 shares common, $100 expenses:

Following firms were paid for services rendered during 1960: **Kilpatrick, Ballard & Beasley**, legal, $23,171; **Fisher, Phillips & Allen**, legal, $21,402; **Ernst & Ernst**, audit, management consultation, $20,644.

Trans-Texas Airways—R. E. McKaughan, president, $32,700 salary, 32,060 shares of common stock, $7,205 expenses; **H. E. Erdmann**, vice president-operations, $18,000 salary, 5,794 shares of common stock, $932 expenses; **L. J. Eichner**, vice president-traffic, $17,100 salary, 670 shares of common stock, $1,397 expenses; **W. C. Leatherwood**, vice president-purchasing, $11,400 salary, 860 shares of common stock, $330 expenses; **J. M. Brooks**, assistant vice president-operations, $10,500 salary, 1,040 shares of common stock, $602 expenses; **J. K. Ayers**, vice president-public affairs, $11,400 salary, 385 shares of common stock, $2,315 expenses; **P. S. Reid**, vice president-personnel, $10,800 salary, 180 shares of common stock, $38 expenses; **R. E. McKaughan, Jr.**, assistant secretary, $10,200 salary, 5,400 shares of common stock, $1,394 expenses.

Following firms were paid for services rendered during 1960: **Clark, Reed & Clark**, legal, $9,262; **Rogers & Smith**, advertising, $208,856; **Peat, Marwick, Mitchell**, audit, $16,100; **Air Transport Assn.**, various services, $14,051; **Ray & Ray**, legal, $7,469; **Venner & Bernhard**, legal, 8,148.

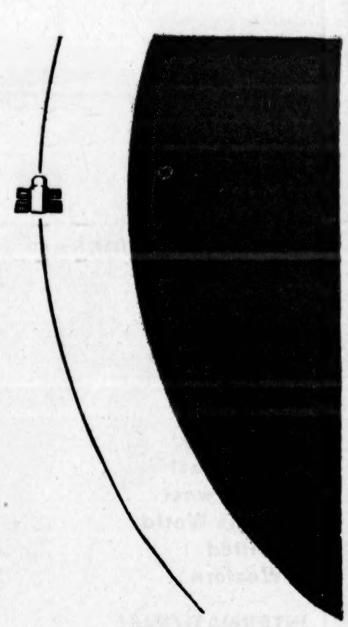
West Coast Airlines—N. Bez, president and director, $19,200 salary, 50,600½ shares of common stock, $137,500 debt securities, $1,267 expenses; **E. B. Code**, vice president, $13,800 salary, 494 shares of common stock, $769 expenses; **T. R. Croson**, vice president, $12,000 salary, 262 shares of common stock, $1,995 expenses; **G. E. Hatch**, vice president (since Apr. 1, 1960), $9,750 salary, 150 shares of common stock, $1,529 expenses; **H. F. Scheurer, Jr.**, vice president, $18,500 salary, 100 shares of common stock, $2,699 expenses; **S. M. Selby**, vice president, $13,200 salary, 50 shares of common stock, $642 expenses; **S. R. Severtson**, vice president, $16,000 salary, 150 shares of common stock, $677 expenses; **W. R. Thrall**, vice president (since Oct. 27, 1960) and director (since Mar. 16, 1960), $15,000 salary, no stock, $186 expenses; **L. J. Hawkinson**, secretary and treasurer, $15,600 salary, five shares of common stock, $1,132 expenses; **K. N. Laurin**, assistant treasurer, $9,201 salary, no stock, $249 expenses; **W. Calvert**, vice president and director, no salary, 9,523 shares of common stock; **J. W. Johnston**, assistant secretary, no salary, no stock; **F. L. Anderson**, director, no salary, 3,045 shares of common stock; **E. K. Bishop**, director, 1,961 shares of common stock, **C. E. Gunderson**, director, no salary, 8,000 shares of common stock; **G. Gunn, Jr.**, director, 1,500 shares of common stock; **P. J. Hillings**, director (since Mar. 16, 1960), no salary, no stock, $508 expenses; **D. Hogue**, director, no salary, 750 shares of common stock; **D. K. MacDonald**, director, no salary, no stock; **T. E. Robinson**, director, no salary, 2,000 shares common.

Following firms were paid for services rendered during 1960: **Alexander Grant Co.**, audit and income tax preparation, $21,119; **C. Edward Leasure**, legal, $11,337; **Washington Employees, Inc.**, labor consultant, $5,846; **Henry Beecken and Associates**, economic consultant, $10,509; **Graham, Green, Dunn, Johnson & Rosenquist**, legal, $16,548.

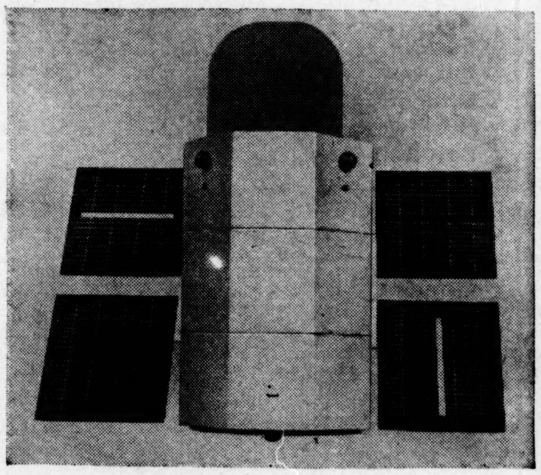
Seaboard World Airlines—R. A. Norden, president, $31,166 salary, 42 shares of common stock, $1,691 expenses; **A. V. Norden**, executive vice president and director, $34,166 salary, 3,342 shares of common stock, $14,019 expenses; **H. Montee**, vice president-Washington, $17,500 salary, 625 shares of common stock, 1,510 shares of common stock in the name of others, $4,836 expenses; term of office expired Nov. 1, 1960 for the officers listed above. Term of office began Nov. 1, 1960 for the following officers:

R. M. Jackson, president and chairman, $14,400 salary, no stock, $1,893 expenses; **J. H. Mahoney**, senior vice president-sales, $3,375 salary, no stock, $668 expenses; **C. D. Brell**, senior vice president-operations, $24,583 salary, no stock, $1,734 expenses; **S. I. Fondiler**, senior vice president-financial, $29,833 salary, no stock, $795 expenses; **W. P. Neth**, vice president and secretary, $22,125 salary, 104 shares of common stock, 4,820 shares of common stock in the name of others, $10,075 expenses; **J. H. Rosenwald**, vice president-administration, $13,950 salary, no stock, 10,993 shares of common stock in the name of others, $165 expenses; **A. Thomson**, vice president-cargo sales $14,750 salary, 104 shares of common stock, $1,480 expenses, $5,000 debt securities.

Following firms were paid for services rendered during 1960: **Lowenstein, Pitcher, Hotchkiss, Amann & Parr**, legal-refinancing, $83,893; **Joel Fischer**, legal-refinancing, $39,406; **Hardy Maclay**, legal, $19,796; **Robert Johnson**, legal, $27,936; **Hazard Advertising**, advertising, $65,324; **Mel Adams & Associates**, public relations counsel, $39,380; **Arthur Young & Co.**, audit, $65,500; **Kramer, Marx, Greenlee & Backus**, legal, refinancing, $55,424; **United Research**, financial survey, $7,252; **White & Case**, legal, $9,500; **Cahill, Gordon, Reindel**, legal, $36,917; **Carl, Loeb, Rhodes**, underwriting, $20,627.



ASTRONOMICAL SATELLITE



National Aeronautics and Space Administration's Astronomical Observatory will be launched 500 miles into space in 1963. It will orbit above the screen of Earth's atmosphere, which distorts and absorbs radiation from stellar objects. Observations through a 36 inch telescope from this vantage point will provide astronomical data unavailable from any ground-based equipment.

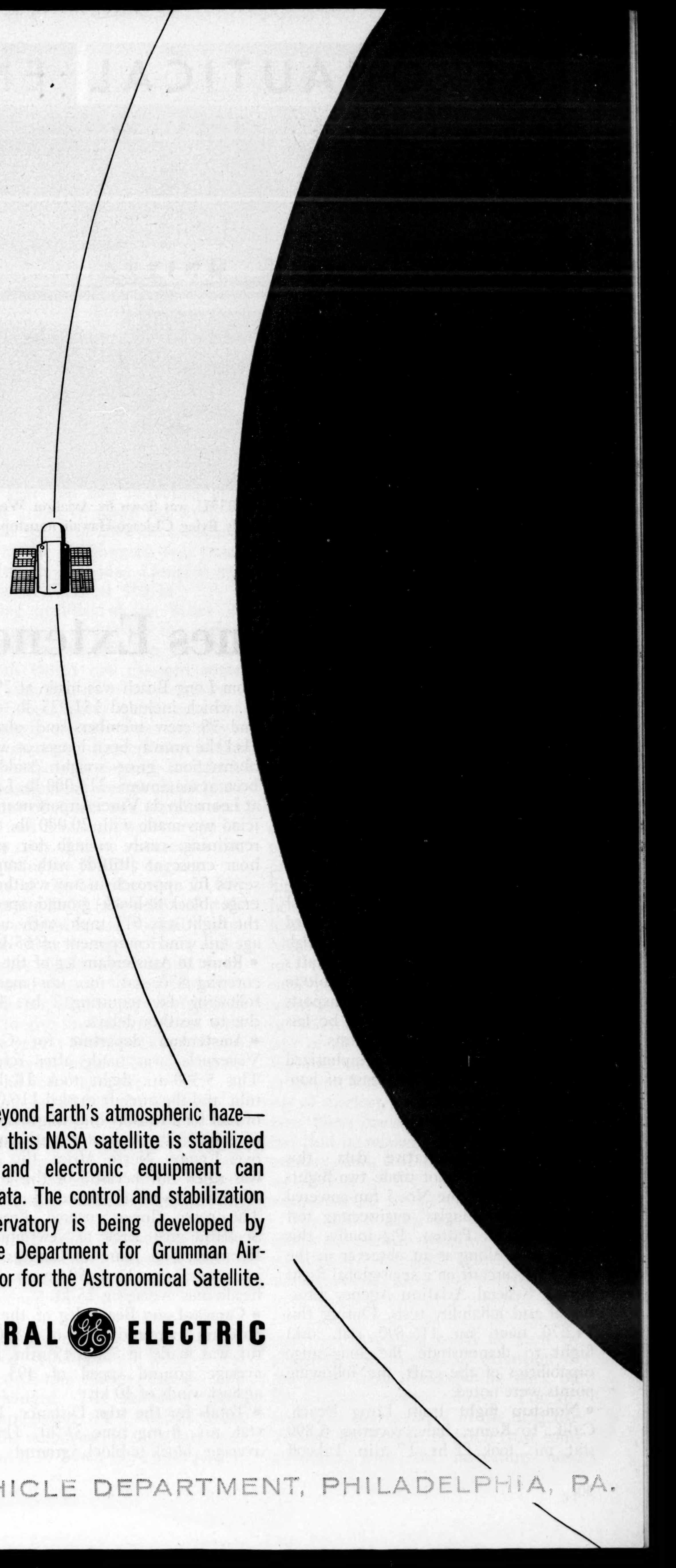
Initial Stabilization—Within five hours after reaching orbit, the Astronomical Satellite's stabilization and control system will eliminate tumbling and roll, and orient its optical axis away from the sun. Reference to a predetermined star pattern will verify initial stabilization.

Accurate Stabilization—Next, the satellite will be pointed and held to within 1.0 minute of arc, using feedback from the system's six star-trackers. Feedback from experimental optics will then be used to stabilize the satellite within 0.1 seconds of arc.

General Electric's Missile and Space Vehicle Department is developing the stabilization and control system for the Astronomical Satellite. Similar systems for Atlas and Thor re-entry vehicles, and Advent and Nimbus satellites have already been designed by MSVD . . . a department of the G.E. Defense Electronics Division.

160-09

GENERAL ELECTRIC



ASTRONOMICAL SATELLITE will orbit beyond Earth's atmospheric haze—historic barrier to man's study of stars. Once this NASA satellite is stabilized in orbit, its ground-controlled telescopic and electronic equipment can automatically observe, collect and transmit data. The control and stabilization system for this orbiting astronomical observatory is being developed by General Electric's Missile and Space Vehicle Department for Grumman Aircraft Engineering Corporation, prime contractor for the Astronomical Satellite.

GENERAL ELECTRIC

MISSILE AND SPACE VEHICLE DEPARTMENT, PHILADELPHIA, PA.

AERONAUTICAL ENGINEERING

FIFTH TURBOFAN-POWERED Douglas DC-8, N8035U, was flown by Aviation Week for this pilot report. United Air Lines plans to use the long-range aircraft on Hawaii service, eventually flying Chicago-Hawaii nonstop. Normal range at full gross is 5,000 naut. mi.

Aviation Week Pilot Report:

Turbofan Engines Extend Range of DC-8

By William S. Reed

Long Beach, Calif.—Despite a 40% increase in takeoff thrust afforded by Pratt & Whitney JT3D-1 turbofan engines, the Douglas Series 50 DC-8 retains good low-speed handling qualities stemming from a control system design attributable in part to limiting wing sweep to 30 degrees.

Although 21 mph. slower in maximum permissible speed than the fastest jet transports, the turbofan-powered DC-8 will cruise economically with high payloads over long ranges. The aircraft's long-range cruise speed is comparable to or better than that of other transports and fuel costs should prove to be less of a factor in direct operating costs.

Douglas says it has emphasized safety, maintainability and ease of handling, in that order.

Qualitative Data

To collect qualitative data, this Aviation Week pilot made two flights totaling 5 hr. in the No. 5 fan-powered aircraft with Douglas' engineering test pilot Paul H. Patten. Previously, this writer rode along as an observer in the No. 3 fan aircraft on a semi-global flight during Federal Aviation Agency functional and reliability tests. During this 14,670 naut. mi. (16,890 stat. mi.) flight to demonstrate the long-range capabilities of the craft, the following points were noted:

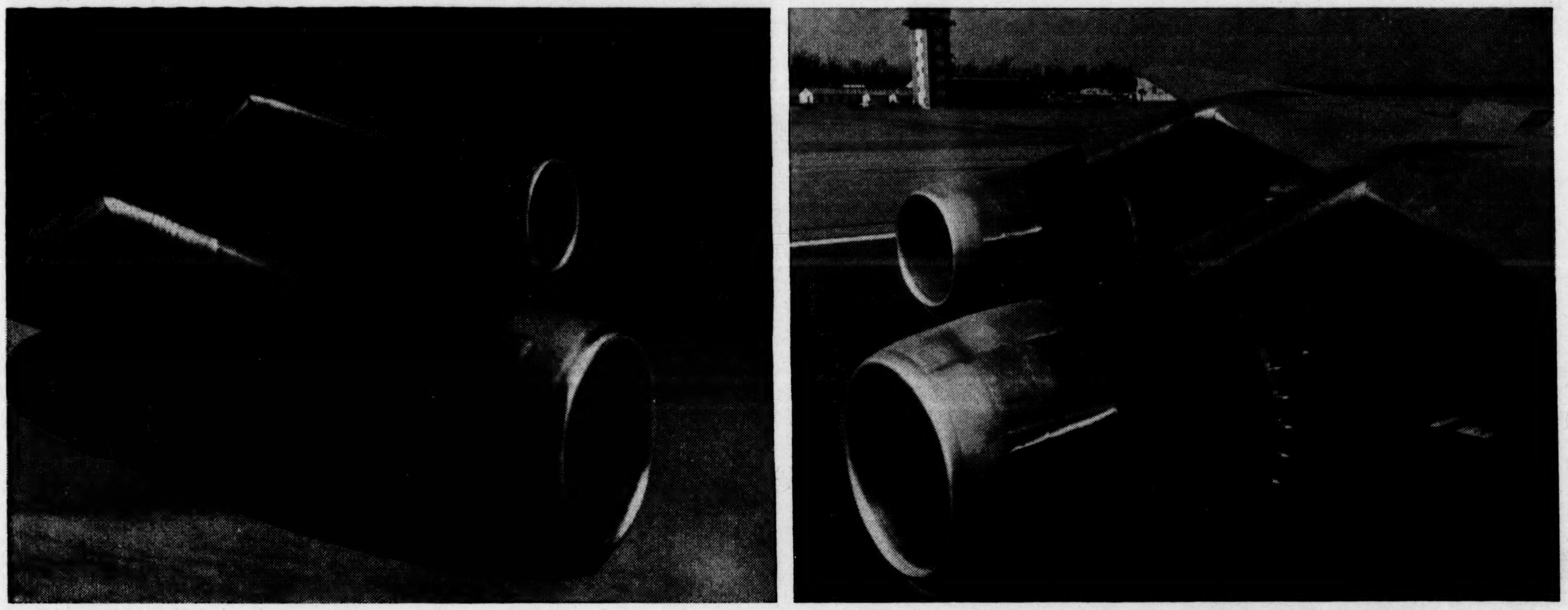
- **Nonstop flight** from Long Beach, Calif., to Rome, Italy, covering 6,890 stat. mi., took 11 hr. 17 min. Takeoff from Long Beach was made at 291,000 lb. which included 151,925 lb. of fuel and 38 crew members and observers. Had the runway been longer or without obstruction, gross weight could have been at maximum—314,000 lb. Landing at Leonardo da Vinci Airport near Fiumicino was made with 20,000 lb. of fuel remaining, easily enough for another hour cruise at altitude with ample reserves for approach in any weather. Average block-to-block ground speed for the flight was 611 mph. with an average tail wind component of 65 kt.
- **Rome to Amsterdam** leg of the flight, covering 870 stat. mi., was made the following day requiring 2 hr. 4 min. due to weather delays.
- **Amsterdam departure** for Caracas, Venezuela, was made after refueling. This 5,300-mi. flight took 10 hr. 33 min. and the aircraft carried 116,000 lb. of fuel for a runway-limited gross weight of 250,000 lb. A shorter southern route over France, North Africa, the Azores was ruled out because of the French-Algeria crisis which closed all air traffic. The route flown covered Prestwick, Scotland; great circle to Newfoundland; Bermuda; San Juan; to Caracas. Average ground speed was 504 mph. against headwinds averaging 25 kt.
- **Caracas-Long Beach** leg of the flight covering a ground track of 3,820 stat. mi. was made in 7 hr. 45 min. for an average ground speed of 493 mph. against winds of 40 kt.
- **Totals for the trip:** Distance, 16,890 stat. mi.; flying time 31 hr. 41 min.; average block-to-block ground speed, 532 mph.; elapsed time from Long Beach departure to return, 68 hr. 42 min.

Servicing and maintenance required during the FAA test flight totaled 72 manhours, all performed by a six-man crew carried aboard on the trip. The aircraft was the second of three Series 50 DC-8s which since have been delivered to KLM Royal Dutch Airlines.

Aircraft used for the Aviation Week flights was N8035U, the 133rd DC-8 off the Douglas line and the second turbofan-powered aircraft in United Air Lines' markings. Ramp weight for the first flight was 189,600 lb. including 58,700 lb. of fuel. Second flight was at a ramp weight of 183,000 lb. including 52,100 lb. of fuel. Both flights were production tests to shake down the various systems in the craft and as such, explored virtually the entire operational performance envelope.

A feeling of familiarity is gained when settling down into the left seat of the DC-8, probably due to Douglas' efforts to make the layout similar to its previous transport aircraft. Of particular note is the convenience of the nose gear steering wheel located near the pilot's left knee and canted at a 30-deg. angle to the vertical. An additional ground handling bonus is offered by "full-time" hydraulic nose gear steering controlled by the rudder pedals.

The wheel is used only for sharp turns such as when the DC-8 was turned 180 deg. in two-thirds of the runway width at Long Beach. At first, drawing on previous experience with nose wheel steer-



FAN CASCADES in the stowed position (left) allow for the smooth flow of bypass air from the forward fan of the JT3D-1 engines. Effectiveness of thrust reversal on all four engines was assessed during a landing (right) at Ontario International Airport, Calif.

ing arrangements coupled to the rudder pedals, a somewhat skeptical view was taken of this arrangement. It was anticipated that steering would become over-sensitive as ground speed built up, especially near rudder effectiveness speed. As it turned out, the steering, even at near-rotation speed, does not become sensitive or require any special technique.

Performance indicated by a data sheet compiled by Douglas for training showed that for the existing temperature, 65F, refusal speed, (V_1), was 116 kt.; rotation speed, (V_R), was 131 kt. and initial climb speed, (V_2), was 146 kt. Stabilizer setting for a center of gravity of 25.1% MAC was .8 units nose down. Minimum ground control speed, V_{MCG} was 113 kt. for the ambient temperature. Actual V_{MCG} is much lower since the minimum was established with the nose wheel steering inoperative.

The first takeoff was made from Runway 30 at Long Beach with strong gusty winds quartering from the left. Directional control was easily maintained without the necessity of using the left hand on the nose gear steering wheel. Some difficulty was experienced in reading the airspeed indicator which uses a pointer cut off at a 45-deg. angle at the tip. Attempting to interpret the point at which the airspeed read 131 kt. is nearly impossible but not critical. Variations in rotation speed up to 10 kt., either side of the speed, demonstrated during FAA abused takeoff tests is not considered to greatly compromise takeoff performance.

Once airborne with gear retracted and flaps up at 160 kt., airspeed was held at 180 kt. while climbing to 2,000 ft. and turning to a heading of 180 deg. Airspeed was increased to 280 kt. after clearing the congested area and only then was it noted that elevator trim had not been used since brake release. The aircraft remained in trim throughout rotation, gear and flap retraction and leveloff at 2,000 ft. mean sea level. A best climb speed of 280 kt. is recommended in the fan-powered type compared with the previous Douglas jets which operated best at 310 kt.

Handling qualities of the Series 50 is in all respects similar to the earlier DC-8s (AW Apr. 4, 1960, p. 80). The increase in thrust has changed some numbers with regards to minimum control speed, best climb speed, etc., but control system changes were not necessitated by increased thrust. Power of the Rolls-Royce Conway engines, for which design consideration was given, dictated the amount of rudder and elevator area necessary and it was not necessary to increase the sizes of these surfaces for the Pratt & Whitney JT3D-1 engines.

A series of climbing turns to 20,000 ft. showed the DC-8 to handle well with respect to control forces. Visibility is on a par with other transports but a somewhat higher climb angle results from the increased thrust. Aileron control is smooth during all rates of roll (spoilers are used to give increased response only when the gear is down) although forces seem somewhat high. This does make for a "solid feel," however.

Leveling at 20,000 ft., a series of stalls was performed. The first, in a clean configuration, saw the aircraft pay off at an airspeed of 125 kt. Mild buffetting started at about 140 kt., increasing in intensity until it became very heavy at the stall. Control remained positive at all times. In landing configuration, the aircraft stalled at 98 kt. IAS with 50 deg. flaps extended. Control remained equally good.

Acceleration back to climb speed of 280 kt. showed that the DC-8 has positive speed stability with positive but not excessive trim change required with power changed. The automatic pitch trim compensator (PTC) which trims against the aerodynamic tuck that commences at 0.70 Mach came into play as 280 kt. appeared on the airspeed.

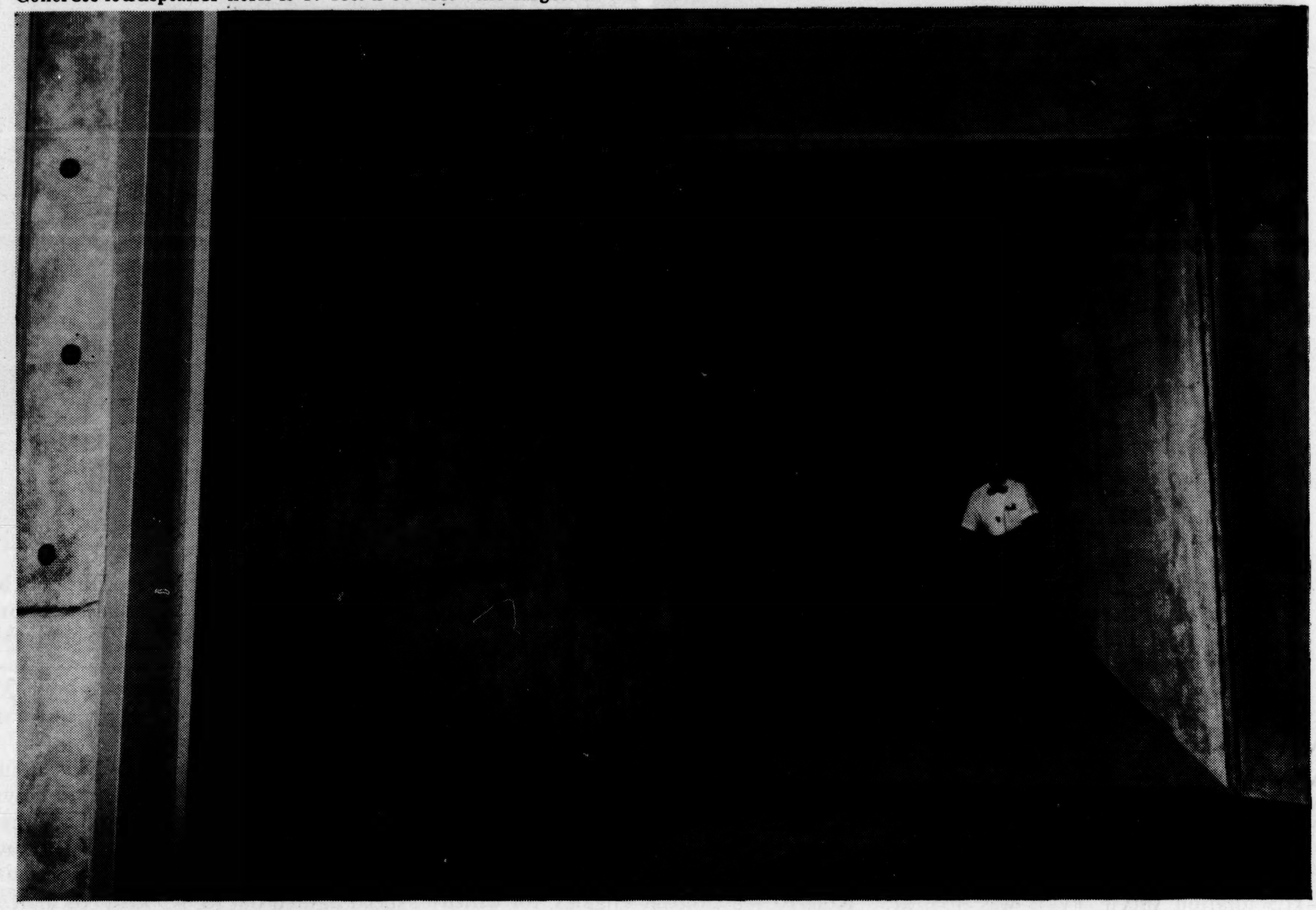
Climb schedule was held at 0.75 Mach when it coincided with 280 at 30,000 ft. This was held until leveling off at 35,000 ft. indicating .75 and 250 kt.

Climb to 35,000 ft. took about 35 min. including time out for a series of stalls at 20,000 ft.

Cruise conditions were established at 35,000 ft. and the aircraft settled down to an indicated .82 Mach (.825 true) with EPR setting at 1.59. Fuel flow was 2,550 lb./hr./engine and true airspeed figured out to 475 kt. (548 mph.). At long-range cruise, the aircraft would be cruised at .81 indicated, and climbed as traffic dictated to near the maximum certificated altitude at 42,000 ft. This procedure was used on the nonstop flight to Rome and will undoubtedly be used by KLM and United on long hauls. Operating at faster cruising Mach numbers puts the aircraft farther into the drag rise which yields only small percentages of increase in true airspeed out of all proportion to increases in fuel consumption. This is characteristic of all large swept wing jets which find their most economical cruise speeds at around 0.80 to 0.82. Only the necessity of meeting advertised schedules dictates faster cruising speeds despite the fact that increasing speed by 0.02 Mach number, from 0.82 to 0.84 for example, an increase of 2%, will see fuel consumption rise by 12%.

The DC-8 then was taken out to where the normal operating limit (V_{mo}) warning bell sounded. Handling qualities remained good and aerodynamic noise increase was at a nominal level. Just how far into the drag rise the aircraft was operating could be seen by observing the amount of extension of the pitch trim compensating stick on the copilot's control column. The aircraft also was operated in the drag rise without the benefit of pitch trim compensation with the increasing nose

Concrete loudspeaker horn is 47 feet x 30 feet—the largest in the world.



Mach 3 Technology

Torturing aircraft structures with the world's largest "gramaphone" To predetermine in-flight stresses on an aircraft as advanced as the Air Force's Mach 3 B-70 Valkyrie, it was necessary to make sweeping advances in the state-of-the-art of testing procedures.

One way the Los Angeles Division of North American Aviation met this challenge was to build the largest, loudest acoustical test chamber in the world. Here, a mammoth 47 foot by 30 foot concrete loudspeaker horn can blast aircraft structural specimens with up to 170 decibels of noise. This is the equivalent of 54,000 five-tube radios going full blast, yet ingenious soundproofing keeps this noise to no more than a discreet whisper outside the lab. The noise inside the lab is so great that the heat generated could ignite fiber glass insulating material.

Specimens up to 6 feet by 25 feet can be tested in the acoustical lab. It has the capacity for: progressive wave as well as reverberant sound fields; grazing or normal incidence specimen orientation; discrete frequency or random noise at sound levels up to 170 dbs; thermal environment testing from −100°F to +1200°F; frequencies of 50 to 10,000 cycles per second. This is indeed a remarkable facility for acoustical testing, fatigue testing, and vibration testing.

This giant acoustical laboratory can not only carry out testing on tomorrow's Mach 3 aircraft, but can perform tests on aerospace craft still ten years from reality. The lab is only one of the many that the Los Angeles Division has developed to conquer problems of space age flight.

Builders of the B-70 Valkyrie

THE LOS ANGELES DIVISION OF **NORTH AMERICAN AVIATION**

down moment becoming obvious as speed built up. It was possible, however, to hold straight and level without trimming but at the expense of considerable full force on the wheel. Force required is not high enough for malfunction of PTC to be a "no-go" item in passenger operation.

Stabilizer trim is accomplished either by a thumb-operated switch on the control wheel or by use of a conventionally located trim system on the center pedestal. Button-operated aileron trim is not included in the DC-8 in the form of a four-way switch, i.e., fore and aft for elevator trim, side to side for aileron. It is necessary to reach the aileron trim knob with the right hand and the position is somewhat awkward since the knob is located behind the plane of the pilot's seat back.

Recovery from pilot-induced instability such as Dutch roll was accomplished by straight forward techniques both visually and on instruments, i.e., wings level by use of aileron, yaw stopped by use of rudder.

Thrust reversing is very effectively provided by a fan cascade reverser for the bypassed air and by main exhaust gas reverser cover doors. Operation is pneumatically powered and designed fail-safe so that any malfunction in the system will cause the reversers to fail in the "off" position. Actuation is rapid with only a brief pause at idle rpm. necessary while the mechanism is in transition. Position lights on the instrument panel let the pilot know the reverser positions.

In flight, numbers two and three engines can be operated in reverse thrust up to maximum continuous power assuring that rapid descent can be made in case of emergency. Lockout devices prevent numbers one and four engines from being reversed unless there is weight on the landing gear.

The DC-8 employs no other high speed drag or braking device other than thrust reversal which appears to cause less buffetting and milder trim changes than spoilers or other speed brakes.

Emergency descent was demonstrated while at 35,000 ft. from a cruise speed near Mach 0.88. All engines were cut to idle and the thrust reverser levers on the inboards were pulled back as soon as two and three slowed to idle. Once the actuator lights showed that the reverser cycle was complete, maximum continuous power was applied to the inboards while nosing over severely to maintain 0.80 Mach number or the maximum limit airspeed. Floor angle is near 30 deg. and the rate of descent about 13,000 fpm. Descent from 42,000 to 12,000 can be made in this manner in less than 2.5 min.

Leveling off again at 15,000 ft., maneuvers consisting of steep banks with one and two engines out were made with the boost on rudder and aileron disconnected. Although not capable of rolling with fighter-like agility in this state, the DC-8 was safely controlled through all necessary maneuvers.

One landing was made at Ontario International Airport to check the functioning of the automatic approach coupler with the ILS. Downwind leg was flown at 180 kt. with flaps up. The aircraft's gross weight by this time was 173,000 lb. Flaps were lowered to 25 deg. and airspeed reduced to 145 kt. prior to intercepting the runway localizer. The coupler worked very well despite the severe test of intercepting the localizer at a 60-deg. angle. At glide slope interception, airspeed was reduced to 137 kt. as the flaps were lowered to 50 deg. Automatic approach was discontinued at the middle marker and a visual landing executed without additional trim from approach speed. Flare speed for this weight was 122 kt. Lateral control is positive and requires no "leading" on the pilot's part.

Conventional Landing

The DC-8 is landed in a conventional manner with the attitude of the nose rising steadily as the airspeed bleeds off, much as the procedure with straight-wing aircraft. It is in every respect an easy aircraft to land and does not require any reorientation of thinking. Once the main gear is firmly on the ground the nose gear is lowered, whereupon the wing spoilers automatically deploy, providing the copilot's selector has been placed in the armed position. Directional control is handily maintained with the coupled nose gear steering by rudder pedal requiring no transition to the hand wheel.

Reversers are put into operation and when the transition lights indicate all four are in position, reverse thrust is applied. Maximum continuous power can be applied to all four engines down to a speed of about 70 kt. Below that, foreign object ingestion may occur and thrust usually is reduced to reverse idle except in an emergency.

Takeoff from Ontario at 172,000 lb. was conducted with numbers three and four engines retarded to idle after passing V_1 speed. Directional control was maintained without trouble and rudder force was not excessive on the climbout.

Two landings were made at Long Beach, one on each of the separate flights. Gross weight on landing after the first flight was about 178,000 lb. for which the book showed flare speed to be 124 kt.

Second landing at Long Beach runway was by this time made with some familiarity with the aircraft. Flare speed was 1 kt. slower, 121 kt., and the sharp turnaround capability was demonstrated in order to turn and backtrack on the active runway.

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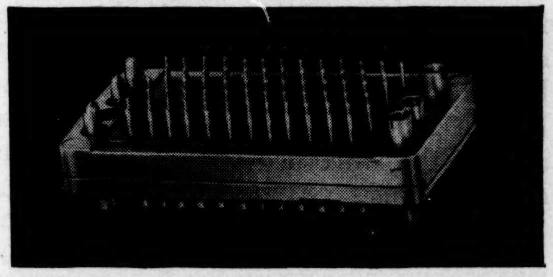

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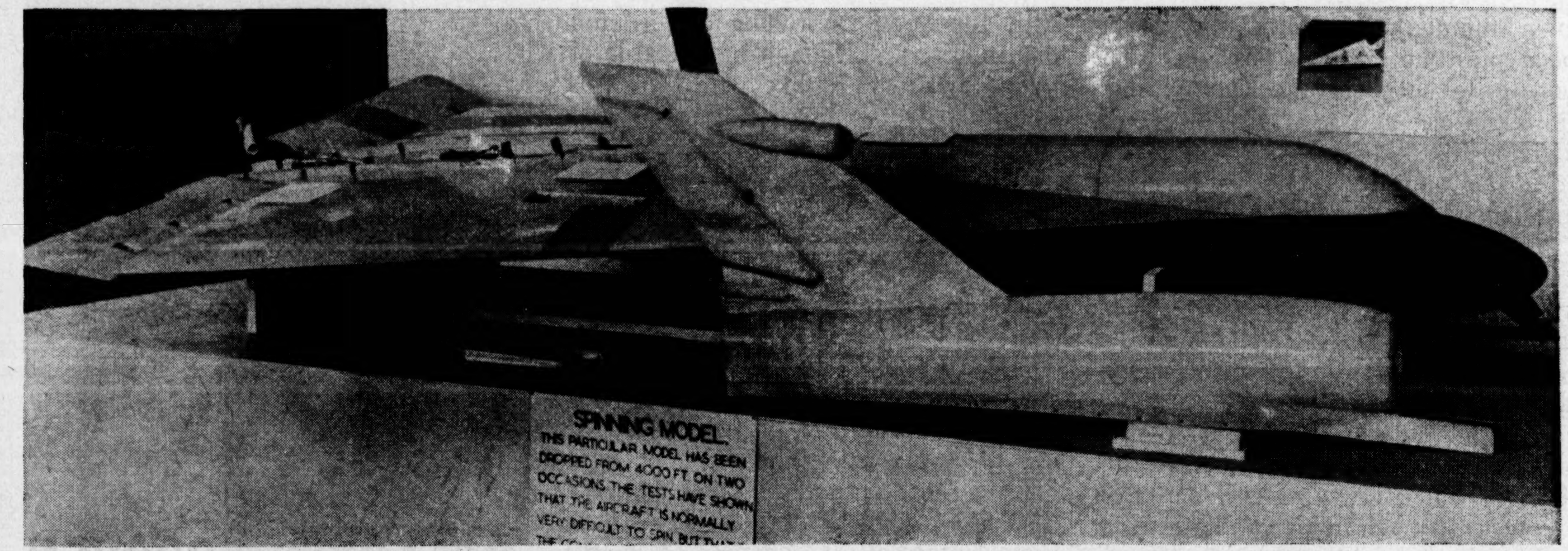

SPINNING MODEL.
THIS PARTICULAR MODEL HAS BEEN DROPPED FROM 4000 FT. ON TWO OCCASIONS. THE TESTS HAVE SHOWN THAT THE AIRCRAFT IS NORMALLY VERY DIFFICULT TO SPIN BUT THA

GLASS FIBER and balsa model has been dropped from 4,000 ft. to test spin characteristics of Handley Page 115 low-speed, slim delta research craft, due to fly this summer. Engineers say the 115 will be difficult to spin. Normal recovery means are effective.

British Study Space, Supersonic Craft

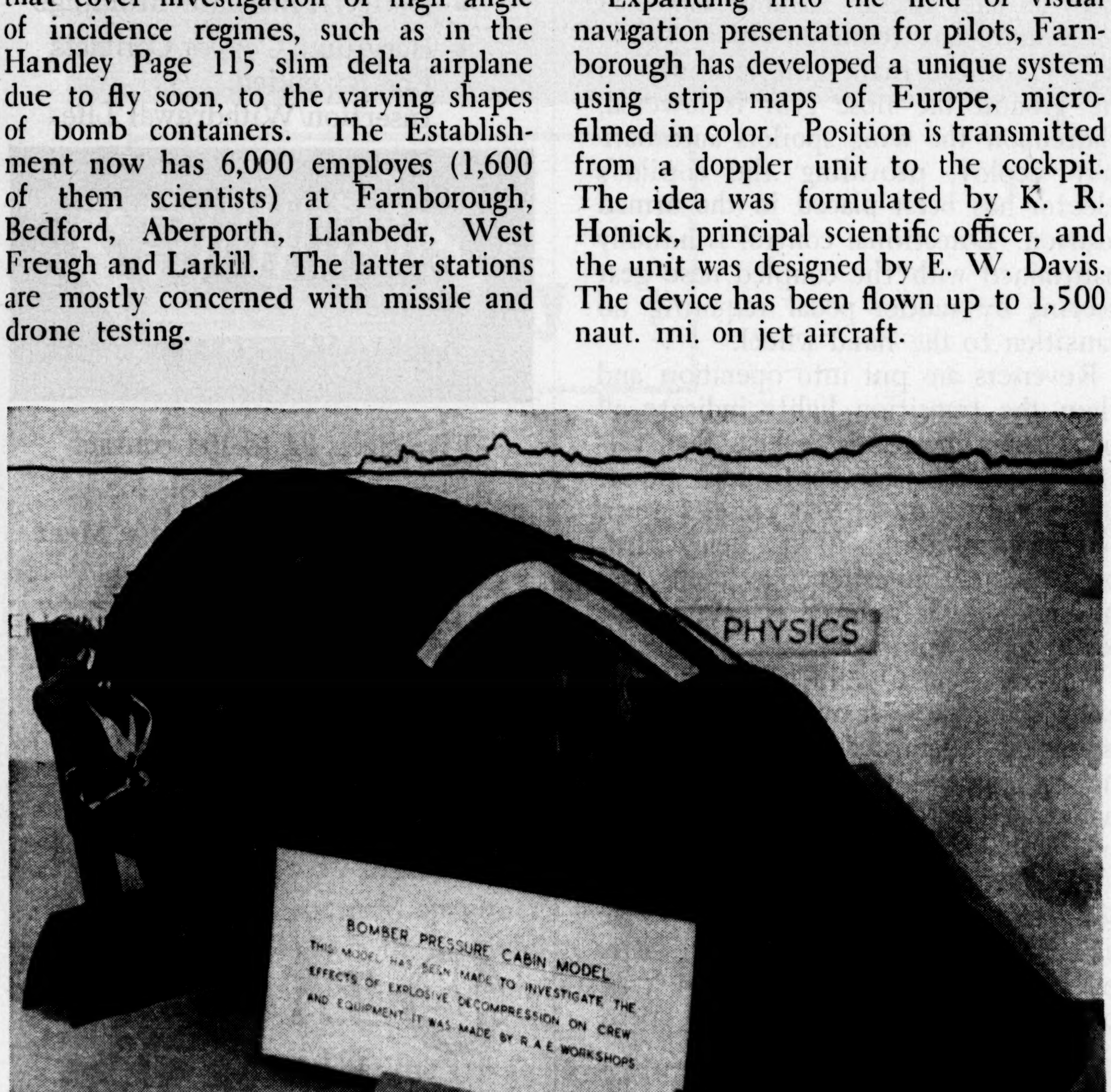
By Herbert J. Coleman

Farnborough–Britain's Royal Aircraft Establishment is working on a wide variety of designs ranging from space vehicles to aerodynamic problems of supersonic transports.

In a limited showing, RAE engineers revealed some aspects of studies that cover investigation of high angle of incidence regimes, such as in the Handley Page 115 slim delta airplane due to fly soon, to the varying shapes of bomb containers. The Establishment now has 6,000 employes (1,600 of them scientists) at Farnborough, Bedford, Aberporth, Llanbedr, West Freugh and Larkill. The latter stations are mostly concerned with missile and drone testing.

At Bedford, engineers use varied wind tunnels, from low speed to hypersonic, to test VTOL models, buffet effects on flows over cavities, such as bomb bays, and measurements of shock patterns using the Schlieren technique. Considerable static test work on the Mach 2 Bristol T.188 has been done at Farnborough and Bedford.

Expanding into the field of visual navigation presentation for pilots, Farnborough has developed a unique system using strip maps of Europe, microfilmed in color. Position is transmitted from a doppler unit to the cockpit. The idea was formulated by K. R. Honick, principal scientific officer, and the unit was designed by E. W. Davis. The device has been flown up to 1,500 naut. mi. on jet aircraft.


PHYSICS
BOMBER PRESSURE CABIN MODEL
THIS MODEL HAS BEEN MADE TO INVESTIGATE THE EFFECTS OF EXPLOSIVE DECOMPRESSION ON CREW AND EQUIPMENT. IT WAS MADE BY R.A.E. WORKSHOPS

EXPLOSIVE DECOMPRESSION effects are studied in cabin corresponding to Victor and Vulcan cockpit shapes by Britain's Royal Aircraft Establishment.

The display shows the airplane's ground position and track superimposed on the colored topographical map in a circular area of about 45 naut. mi.; the scale can be either 1:500,000 or 1:1,000,000.

This display is driven from a navigational computer which combines drift angle with heading to determine the track; ground speed is resolved into north-south and east-west components.

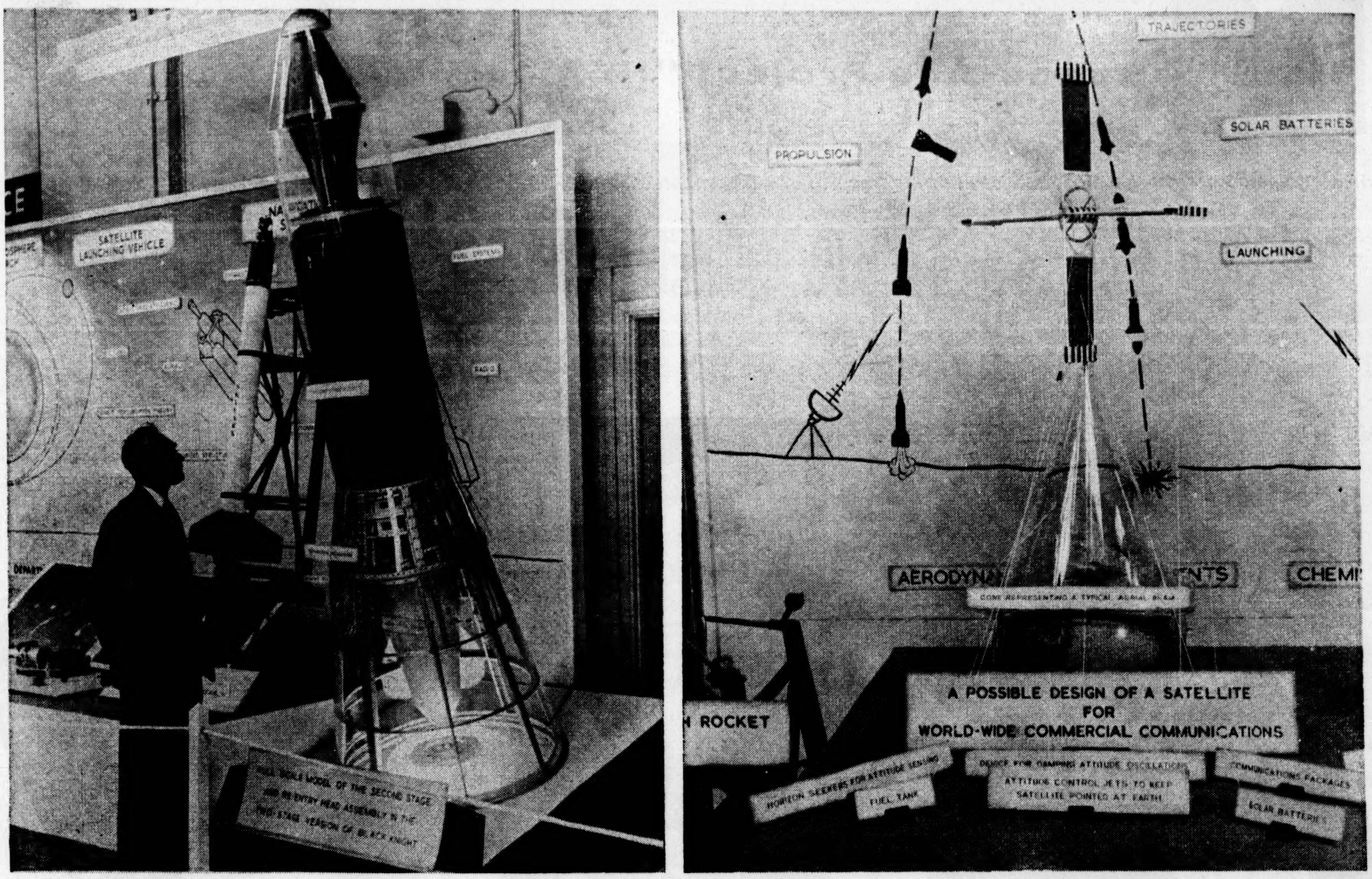
The computer also has a memory store for adjustments in flight. Through the microfilm device, the whole of Europe, as well as North Africa, is contained on a 9½-ft. film roll which can be controlled by the pilot. The instrument was first flight-tested in February, 1960. Component parts were built by L. Adams, Ltd. Commercial aspects have not yet been explored.

Recent Activities

In recent times, the Royal Aircraft Establishment has directed more of its attention and capabilities toward major accident investigations and the life sciences, according to M. J. Lighthill, director. This work has resulted in development of cabin pressurization devices and a Type B full-pressure suit used when cabin pressure is lost.

The suit is lightweight and consists of a rubberized fabric inner layer, terylene outer layer, and a folding helment with a transparent Melinex window which snaps shut over the pilot's head in an emergency. The suit weighs only about 12 lb. and gives the pilot a high degree of mobility.

Lighthill said considerable emphasis now is given to supersonic transports, in cooperation with French ONERA; the British are working on a long-range model of a Mach 2-plus airplane, and the French are interested in medium-range transports. Lighthill predicted a supersonic transport will be built


SATELLITE LAUNCHING VEHICLE
TRAJECTORIES
SOLAR BATTERIES
PROPULSION
LAUNCHING
AERODYN
NTS
CHEMI
A POSSIBLE DESIGN OF A SATELLITE FOR WORLD-WIDE COMMERCIAL COMMUNICATIONS
H ROCKET
FUEL TANK
ATTITUDE CONTROL JETS TO KEEP SATELLITE POINTED AT EARTH
SOLAR BATTERIES

BLACK KNIGHT re-entry rocket (left), can reach 1,600-mi. altitude. Model communication satellite (right) has solar batteries.

within five years and could be in service before 1970 at operating costs comparable with today's big jets.

In other transport applications, Lighthill said the Farnborough team now is working on modifications to tip-jet silencers on the Rotodyne VTOL transport and contended that "difficulties with noise on this aircraft can be resolved."

Turning to space, Lighthill said RAE is "putting all our weight on this," and mentioned development of a communication satellite in conjunction with the British General Post Office. Successful orbiting of such a device, Lighthill emphasized, would put Britain in a good negotiating position with other countries. He was opposed to "putting a dead weight in orbit," contending that any device "must work for you to be of any value."

Paddlewheel Design

One communications design, which RAE personnel stressed was only a "possibility" in the field, is the four-bladed paddlewheel type, with solar batteries contained in the paddles and communications equipment in the blade tips. Fuel would be in the hub and probably would be some form of propane. RAE said the satellite would be stabilized in relation to earth and 400 channels of communication would be available in this particular concept.

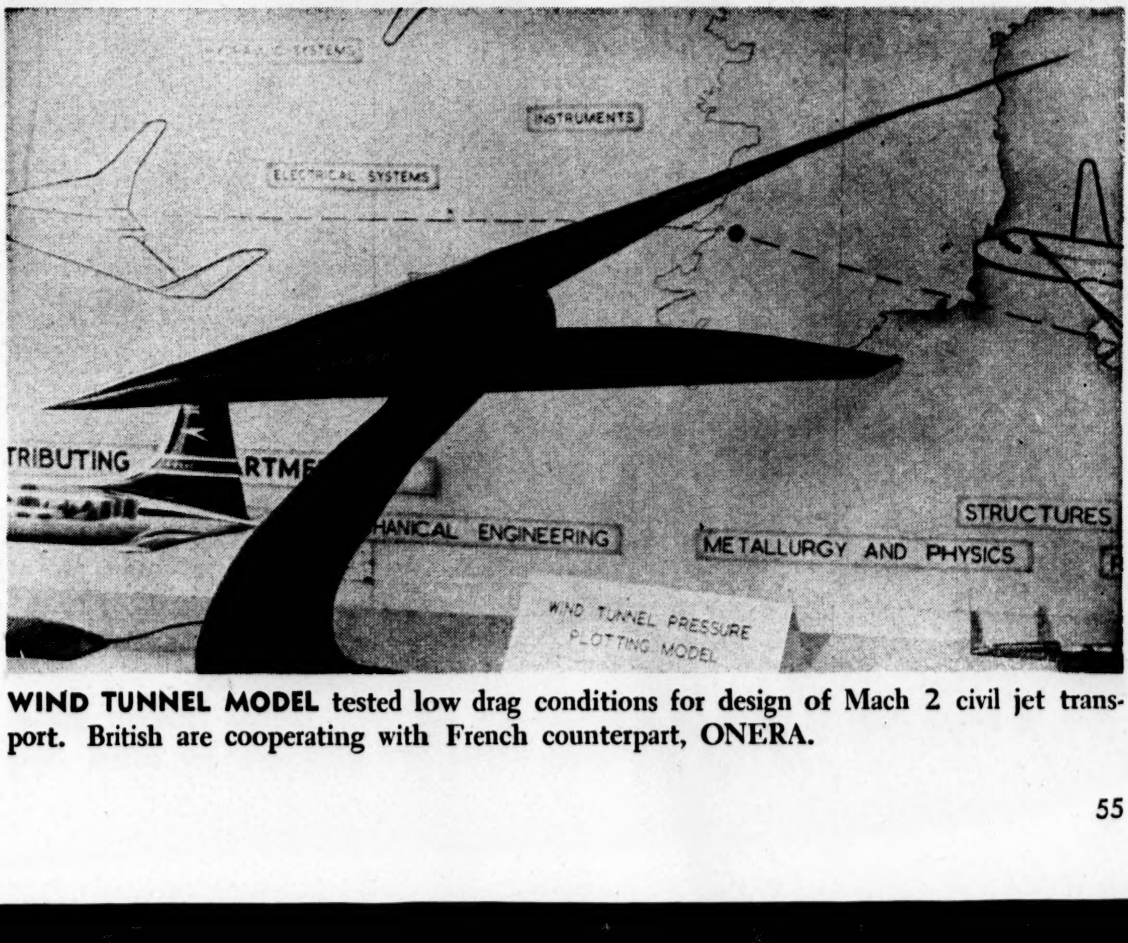
Lighthill said satellites such as this could be put in orbit using the de Havilland Blue Streak as a first stage, plus the French Veronique and another unnamed stage, a proposal which has been pressed for a European consortium of nations by Minister of Aviation Peter Thorneycroft.

Flight Tests

Farnborough does considerable flight test work and currently is flying an Avro 707C in investigation of electrical control systems. The airplane is a tandem two-seater with right seat section fitted with varied electrical pick-offs which actuate hydraulic controls. A Vulcan also is being used for various Blue Steel standoff bomb-mounting tests.

Gust effects on helicopter rotor blades are being studied on a Bristol Sycamore helicopter, with an instrumented de Havilland Chipmunk flying nearby to make photographic and electronic measurements in often severe conditions.

Another test project involves a Gloster Javelin fitted with a device tapping bleed engine air to blow rain off the pilot's windshield. This airplane has flown considerable hours in zero visibility conditions at Singapore; recorders mounted on the wing measure

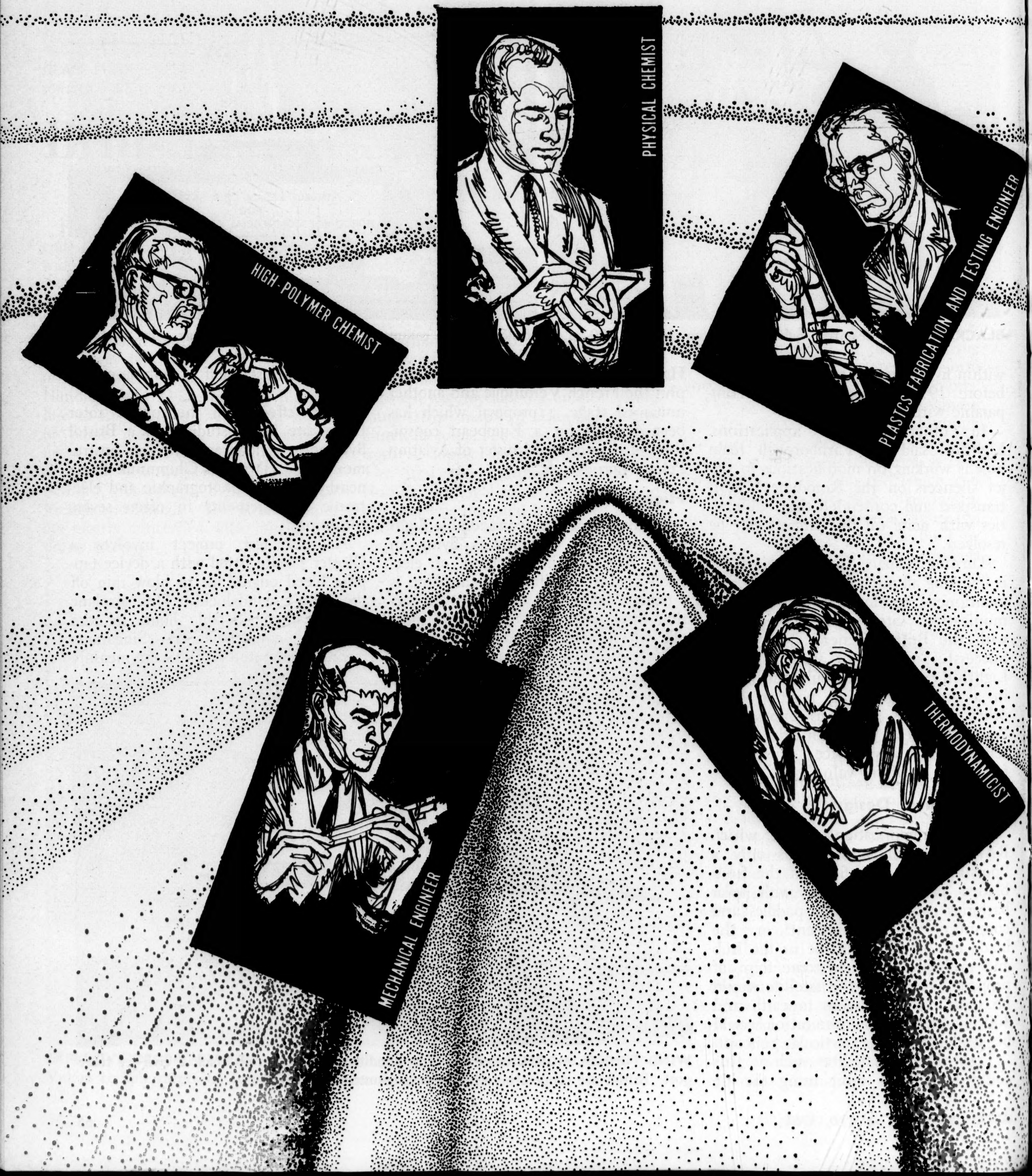

INSTRUMENTS
ELECTRICAL SYSTEMS
TRIBUTING
RTME
HANICAL ENGINEERING
METALLURGY AND PHYSICS
STRUCTURES
WIND TUNNEL PRESSURE PLOTTING MODEL

WIND TUNNEL MODEL tested low drag conditions for design of Mach 2 civil jet transport. British are cooperating with French counterpart, ONERA.

Monsanto

Space-Age Project "HEAT FOIL"

A CHEMICAL EXPEDITION...


PHYSICAL CHEMIST
HIGH-POLYMER CHEMIST
PLASTICS FABRICATION AND TESTING ENGINEER
MECHANICAL ENGINEER
THERMODYNAMICIST

...searching for plastics materials that can "take" temperatures of 20,000° F. plus

Monsanto has developed high-heat-resistant resins for laminates that remain intact for upwards of 2-3 minutes at temperatures as high as 20,000° F.; that maintain integrity for 200 hours at 600° F. Under evaluation are plastics laminates that hold promise for rocket nose cones, nozzles, and other components exposed to high heat.

By applying basic knowledge of polymer chemistry to the problem of service life under heat, Monsanto is making new breakthroughs on the problem of high-heat resistance with plastics. One of the most promising plastics now being evaluated is a silane-modified phenol-formaldehyde resin which makes laminates and moldings that retain integrity after hundreds of hours of exposure to temperatures of 500-600° F. Still other polymers under development hold promise of broadening temperature resistance for increasing lengths of time.

MOLECULAR DISSOCIATION SETS UP COOLING ACTION

Some resins under study form a char layer which insulates the interior and reradiates a large portion of frictional energy. Plastics laminates made from such resins provide insulating walls for interior surfaces or areas.

HEAT RESISTANCE—PLUS STRENGTH AND LIGHT WEIGHT

As in many other fields, laboratory tests for space-vehicle science are hard to correlate with actual field performance. In standard Oxyacetylene Tests and Stabilized-Arc Tests, heat-resistant plastics laminates show adequate retention of structural integrity under high-heat stress.

Like other, more common reinforced plastics, the new heat-resistant laminates have exceptional mechanical strength. The following table indicates some of the mechanical properties obtained with a 1/8" section of a laminate made with a Monsanto silane-modified phenol-formaldehyde resin.

Property	Results	MIL-R-9299 Specifications
Flexural Flatwise		
Standard Condition 75° F.	73,800 psi	50,000
30-Day Water Immersion	73,400 psi	45,000
½ hr. @ 500° F.	62,900 psi	40,000
100 hrs. @ 500° F.	57,600 psi	20,000
200 hrs. @ 600° F.	22,600 psi	No Spec.
Modulus of Elasticity		
Standard Condition 75° F.	3.72×10^6	3.0×10^6
30-Day Water Immersion	3.65×10^6	3.65×10^6
100 hrs. @ 500° F.	3.28×10^6	2.5×10^6
200 hrs. @ 600° F.	1.48×10^6	No Spec.
Tensile Strength		
Standard Condition 75° F.	45,600 psi	40,000
30-Day Water Immersion	45,400 psi	38,000
100 hrs. @ 600° F.	23,100 psi	No Spec.
Edgewise Compression		
Standard Condition 75° F.	50,800 psi	35,000
30-Day Water Immersion	42,000 psi	30,000
100 hrs. @ 600° F.	8,240 psi	No Spec.
Barcol Hardness	76	55
Flammability	Self-extinguishing	1.0 max.

Mechanical Properties of Resinox® SC-1013 Laminates. (1/8" section; E.C.D. 225-181 glass cloth; 12 ply; 200-psi pressure cured 1 hr. at 250° F.; post cured in gradients of 50° F./24 hrs. each to 500° F.; resin content 29%) (Tests carried out as specified by MIL-R-9299)

COMMERCIAL PROMISE, TOO!

In addition to the properties described, the plastics laminates created for high-heat resistance are practically immune to fuels, oils, and solvents.

(Please turn page)

OUTSTANDING ELECTRICAL PROPERTIES

Heat-resistant plastics laminates have also shown outstanding performance in electronic applications wherever frequent cycles of heat and cold are a problem. While maintaining mechanical strength, plastics laminates (as described) showed no degradation of dielectric constant or loss tangent. The following table shows results on a typical panel after various numbers of cycles of heating for one hour at 550° F., then cooling ¼ hour to room temperature.

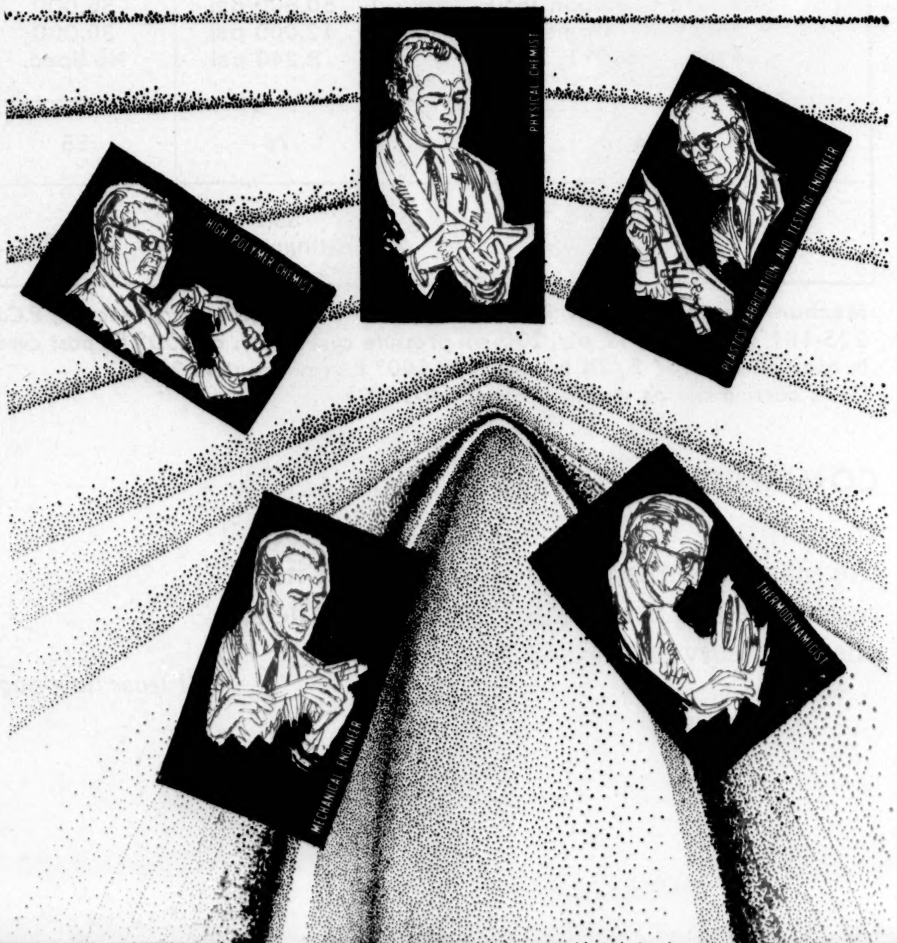
ELECTRICAL PROPERTIES AFTER CYCLING

(Approximately 9 KMC Resonant Cavity)

No. of Cycles (1 hr. at 550° F.; ¼ hr. to 77° F.)	Room-Temperature Electrical Properties	
	Dielectric Constant	Loss Tangent
0	4.8007	0.0217
100	4.7289	0.0218
150	4.7347	0.0218
200	4.7218	0.0214

OPTIMUM PARTS PERFORMANCE

In fabricating parts for optimum performance under high-heat conditions—fibrous glass, asbestos, or nylon is impregnated with resin, is molded, filament-wound or laminated by any of several methods, then cured.



THE CONTINUING SEARCH

Project "Heat Foil" is a continuing study of resins for high-heat resistance and of resins whose energy of dissociation makes them outstanding for high-temperature applications. This search will continue to develop materials that will help answer the high-heat requirements of a space age, in defense and industry. MONSANTO CHEMICAL COMPANY, Department AV-6, C Building, St. Louis 66, Missouri.

Monsanto Space-Age Projects for Government and Industry

- ∗ High-Temperature Hydraulic Fluids
- ∗ Coolant-Dielectrics for Electronic Equipment
- ∗ High-Temperature Plastics
- ∗ Improved Nitrogen Oxidizers for Solid Propellants
- ∗ Fire-Resistant Structural Plastics
- ∗ Hydrocarbon Fuels for Jets and Missiles
- ∗ Fire-Resistant Hydraulic Fluids for Ground-Support and Missile-Launching Equipment
- ∗ Radiation-Resistant Heat-Transfer Fluids
- ∗ High-Temperature Lubricants and Additives
- ∗ Radiation-Resistant Reactor Coolant-Moderators
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- ∗ Pure Silicon for Transistors, Rectifiers, Diodes
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- ∗ Materials for Vibration Damping
- ∗ Heat-Resistant Resins for Laminating and Bonding
- ∗ Inorganic Polymers
- ∗ High-Energy Solid Propellants

You are invited to work with Monsanto on your materials needs in the above fields.

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progress and, in some cases, windshield damage due to driving rain and hail.

Farnborough's Metallurgy and Physics Department is working on metal fatigue and fracturing, with emphasis on development of titanium and aluminum alloys for supersonic transports in which skin temperatures would exceed 100C in kinetic heating. Research on high-temperature materials is primarily centered on graphite and certain carbides.

The Physics Department is exploring the initial stages of hardening of a single crystal under cyclic stress, and problems of surface diffusion and of thermal expansion at high temperature. Another study is of interaction of gas molecules with solid surfaces.

A high-speed track for tests of civil aircraft passenger seats, similar to those used in BOAC Comets and Britannias, has been built on the Farnborough perimeter. Seats are mounted on a rocket-propelled trolley which accelerates to about 30 mph. and is stopped by a hydraulic device utilizing a water-filled cylinder on the trolley and a tapered steel piston which is at the end of the track.

Deceleration is about 6g in 6½ ft. Two dummies ride the seats, which are strain-gaged and connected to recorders by trailing cables. Engineers said seats tested so far would be "satisfactory" in actual crashes of up to 9g forces.

Shown for the first time was an air-launched banner target, developed by the R.F.D. Company, Ltd., of Godalming, and flight tested by RAE on a Gloster Meteor. The nylon target is packed in a light alloy container fitted to a wing pylon on the Meteor and connected, after ejection, by an 800-ft. nylon cord. Attacking aircraft pick up the banner from 6,000 yards by zeroing in on a radar reflector. Entire unit weighs 227 lb.

Indicator on Pressurized Rotor Blades Warns of Crack Initiation

By David A. Anderton

Stratford, Conn.—Pressurized helicopter rotor blades, mounting a telltale device to indicate pressure loss due to crack initiation, will be delivered on the first commercial S-61s by Sikorsky Aircraft Division of United Aircraft Corp.

With this new inspection method, operators will be able to check blade condition during a simple walkaround by ground crew and pilots, rather than having to pull the blades for a two-hour check of their integrity.

If further approval is obtained from Federal Aviation Agency—which now authorizes installation only—operators will be able to run their blades until the tell-tale indicator shows. They now retire all blades, regardless of condition, at 2,500 hr.

Both these factors—reduced inspection time and longer blade life—will effect major savings in direct operating costs of rotary-wing craft.

Other Applications

Sikorsky says all blades from now on will be pressurized. Submission of the S-58 installation to FAA was the first approach; following the S-61 installation, the blades also will be installed on the S-64 crane. U. S. Navy is processing change orders for the HSS-1 and HUS models, but the Army—with a large stock of spare unpressurized blades on hand—isn't quite ready to move.

BIM blades—named for Blade Inspection Method—are interchangeable with current Sikorsky blades. They weigh about 2 lb. per blade more, but interchangeability is effected by changing the non-BIM blade balance weights.

Basic scheme is simple; the blade spar is pressurized to 10 psi., and a simple tell-tale gage is bonded to the inboard root rib. Part of the pre-flight inspection will be to check visually the position of the tell-tale. If it shows red, there is a crack somewhere in the blade, and the blade can then be pulled and replaced.

After the red indicator shows, there is still some life in the blade—perhaps 10 to 100 hr.—so that a helicopter at a remote base could safely be flown back to a maintenance station.

Operators using non-BIM blades can send them back to Sikorsky for rework.

10 Years' Background

The BIM approach is not suddenly new at Sikorsky; it dates back about three years, and can trace its origins about 10 years back.

It started as an inspection technique, growing out of the uncertainties of design. It is difficult to predict blade life, and once having designed the blade, there is nothing that can be done to change its life. Furthermore, the designer can't afford the luxury of high margins of strength; the blade has got to be designed with a life figure in mind.

Blade life—or reliability—is a function of many random variations in its component parts, production and inspection techniques, operating procedures, environment, measuring standards and maintenance techniques. With the tightest possible controls over all controllable variations—those of manufacturing, inspection and maintenance—there is still no way of controlling operating procedures and operating environment.

These two factors weigh heavily in the determination of blade life and are major causes for the wide scatter that occurs in blade life.

Because no designer can control these two items, testing enters the development picture. By a combination of test and calculation, a designer is able to get better control over his design; but he still lacks absolute control. For that reason, life figures are assigned after they have been calculated conservatively.

Current Requirements

This is the basis for current requirements that blades be retired at 2,500 hr. life, or that engines be overhauled at stipulated intervals or that airframes be inspected at certain intervals. But to most designers, throwing all blades away at 2,500 hr. is like throwing out a barrel of apples because one apple has spoiled—all rotor blades do not have the same fatigue life. By using the traditional approach to life expectancy problems, calculations and tests will show that failures can be expected after certain times.

So an arbitrary life limit is set below the calculated and tested scatter, on the theory that this is conservative. It is; it also penalizes the large portion of the items which wouldn't have failed at that time.

Sampling techniques, which are the basis of testing, do not extrapolate well to the whole quantity of items involved. The answer is to get some kind of positive indication that failure is about to take place. Sikorsky's approach has been to develop the tell-tale which shows by indicating a loss of internal blade pressure—that a crack has started and that the blade must be removed.

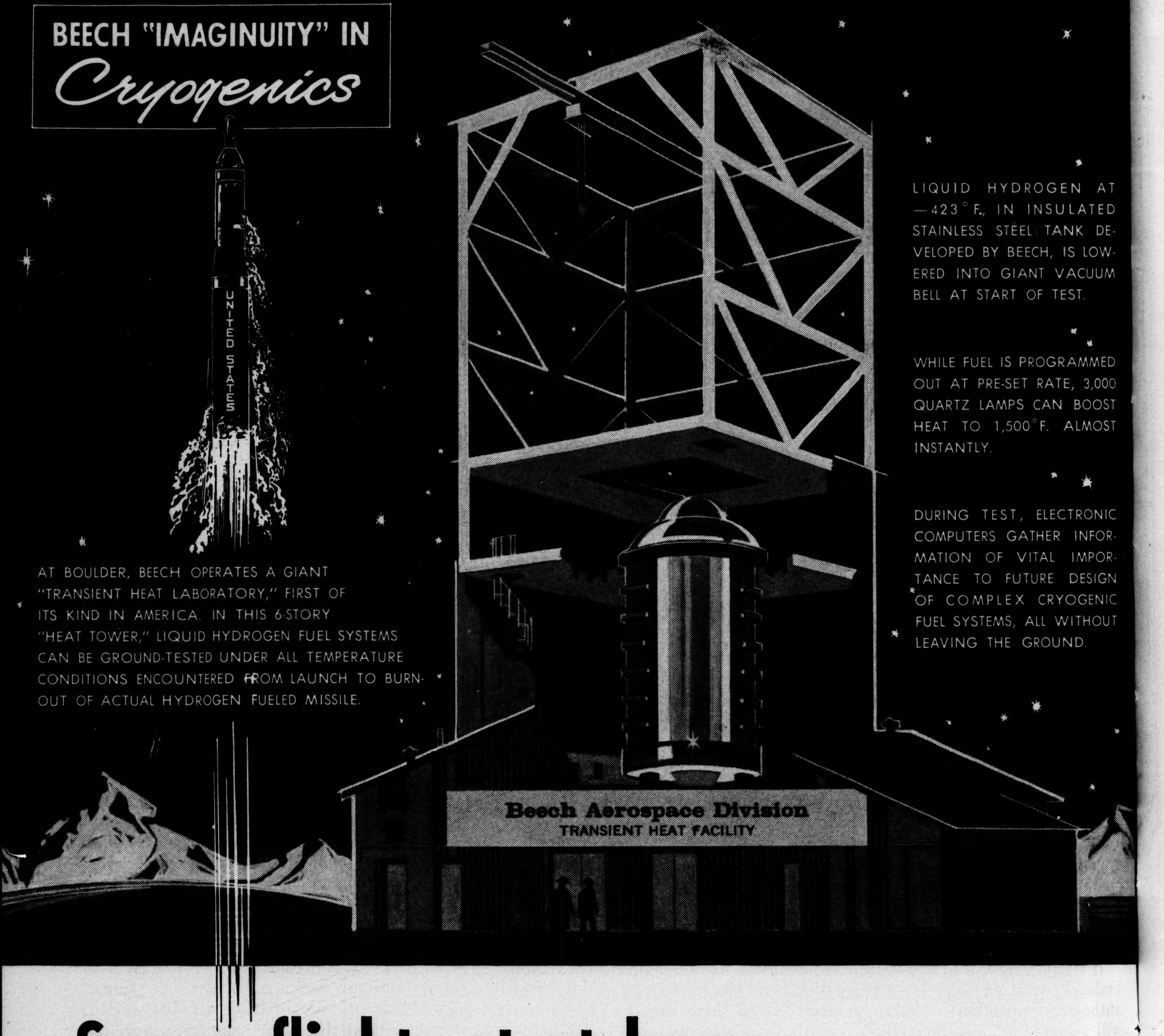
This simple approach is expected to pay dividends to operators, and to feed back useful information to designers for checking their calculations.

Hurricane Mesa To Remain Open

Los Angeles—Plans to shut down Air Force's Hurricane Mesa supersonic test track in Utah have been called off, Coleman Engineering Co., the track operating contractor, reported.

Air Force had ordered the track closed by June 30 because of diminishing need for tests of conventional aircraft escape systems.

Receipt by the contractor of a $300,000 contract for continued testing of the B-58 escape capsule assures that the track will remain in operation, company president T. C. Coleman said.



BEECH "IMAGINUITY" IN
Cryogenics

AT BOULDER, BEECH OPERATES A GIANT "TRANSIENT HEAT LABORATORY," FIRST OF ITS KIND IN AMERICA. IN THIS 6-STORY "HEAT TOWER," LIQUID HYDROGEN FUEL SYSTEMS CAN BE GROUND-TESTED UNDER ALL TEMPERATURE CONDITIONS ENCOUNTERED FROM LAUNCH TO BURN-OUT OF ACTUAL HYDROGEN FUELED MISSILE.

LIQUID HYDROGEN AT —423°F., IN INSULATED STAINLESS STEEL TANK DEVELOPED BY BEECH, IS LOWERED INTO GIANT VACUUM BELL AT START OF TEST.

WHILE FUEL IS PROGRAMMED OUT AT PRE-SET RATE, 3,000 QUARTZ LAMPS CAN BOOST HEAT TO 1,500°F. ALMOST INSTANTLY.

DURING TEST, ELECTRONIC COMPUTERS GATHER INFORMATION OF VITAL IMPORTANCE TO FUTURE DESIGN OF COMPLEX CRYOGENIC FUEL SYSTEMS, ALL WITHOUT LEAVING THE GROUND.

Space flights start here

Before the actual countdown that sends a giant Atlas or Titan ICBM arcing into space, vital propulsion system components of these mighty missiles have thoroughly proved their reliability at the production environmental testing facilities of Beech Aerospace Division near Boulder, Colorado. Here, on a 1,500 acre site near the Bureau of Standards cryogenic engineering laboratory, Beech has assembled a skilled, unified team of scientists, engineers and technicians.

Working with the most modern equipment available (much of it Beech-developed), this team has already made significant contributions to speed America's progress in space technology and advanced weapons systems. Its achievements include noteworthy accomplishments in the fields of advanced propulsion systems and components; liquid hydrogen propellants and liquid hydrogen storage; research, development and fabrication of titanium tankage systems; and environmental testing of a wide range of missile components and systems to qualification.

Because of its experience and facilities, the Beech Aerospace Division team is uniquely qualified to accept many types of challenging new assignments and carry them through rapidly to successful conclusions. May we discuss with you how we may be of service?

Beech *Aerospace Division*

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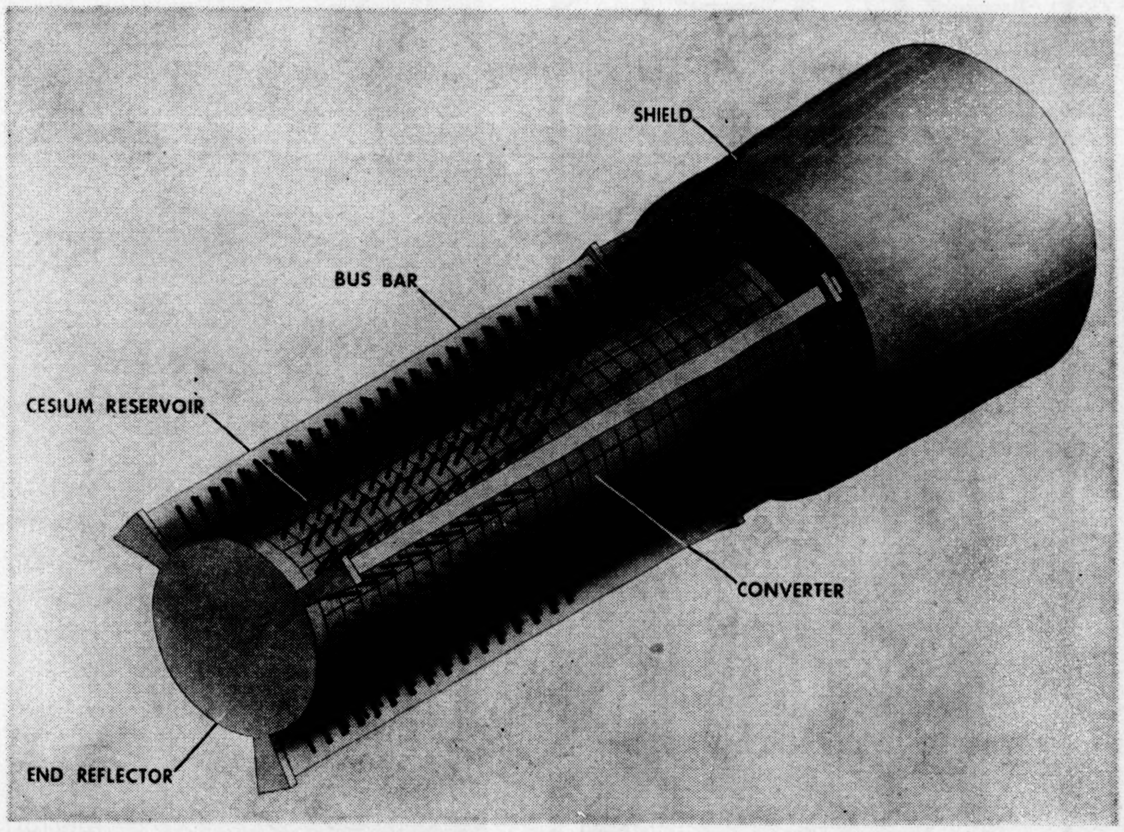
May we help you? Write, wire or phone Roy H. McGregor, Manager, Contract Administration, Beech Aircraft Corp., Wichita 1, Kansas—or nearest Area Office.

AVIONICS

Nuclear-Thermionic Power Unit Proposed

By Barry Miller



COMPACT NUCLEAR-THERMIONIC power supply, called STAR (Space Thermionic Auxiliary Reactor) could supply 70 kw. of electrical power for manned or unmanned space vehicle applications by 1966, according to its designers at GE. Power supply is composed of a number of rings containing fuel elements and parallel-connected thermionic converters.

Pleasanton, Calif. – Concept of a compact nuclear-thermionic power supply which does not require moving parts or fluids during its operation and whose design is sufficiently flexible to be tailored to meet different power requirements is being proposed to the Air Force, Atomic Energy Commission and the National Aeronautics and Space Administration by General Electric Co.

The powerplant, called STAR (Space Thermionic Auxiliary Reactor), is intended to satisfy the electric power needs of avionic and instrumentation gear of future manned and unmanned space vehicles. The STAR concept envisions a cylindrical power supply comprised of a number of repetitive series-connected rings each containing thermionic diodes, fuel elements and reflectors. Specific power requirements can be satisfied by adding enough rings to produce the desired power.

Conversion Gear

With the addition of a suitable conversion gear for boosting its relatively low voltage output, the STAR powerplant also could satisfy the voltage requirements of an ion propulsion engine, according to its designers here at the Vallecitos Atomic Laboratory. Vallecitos is the research center for General Electric's Atomic Power Equipment Department located in nearby San Jose.

General Electric is only one of several organizations working on nuclear thermionic conversion, and one of a still larger group concerned with the use of nuclear energy for space vehicle auxiliary power (AW Aug. 22 p. 69).

A STAR powerplant, weighing about 1,300 lb. and capable of delivering 70 kilowatts of power could be ready for flight in 1966 if the company obtains the funding it is now seeking among space and other government agencies, General Electric engineers say. They estimate that a similar 20-kilowatt prototype supply, fabricated in a step preceding development of a flight model, could be engineered for ground testing two years earlier. The cost of such a program for which preliminary engineering work is complete, would fall between $25 and $30 million, these engineers calculate.

The STAR power source employs the heat generated by nuclear fission in a fast spectrum cylindrical reactor as the heat source for the direct conversion of heat into electricity by thermionic conversion. The thermionic plasma diodes, or converters, are mounted in 1-in. wide circular rings with their cathodes in contact with the reactor's fuel elements and their anodes facing radially outward from the periphery of each ring.

A number of rings are series-connected to synthesize a powerplant of a desired output. The diodes in each ring are in parallel.

Thus, the final supply is a cylindrically shaped stack of 13-in. diameter rings supported by bus bars. The length of the supply is a function of the desired output power; three feet in length for the unit proposed by the company.

Cesium which acts as a form of catalyst for the diode operation is provided for each diode by individual pencil-shaped cesium reservoirs which extend from the outside surface of the converters. The cesium lowers the work function of the cathode material, thereby enabling more electrons to escape from that electrode, and in its ionized state combines with free electrons to reduce the space charge between the cathode and the anode.

Waste heat radiates from the anodes of the converters into free space without requiring separate radiators or other heat transfer mechanisms.

At one end of the reactor is a reflector, also supported by the bus bar structure of the powerplant and protecting the reactor and the converters from damage by micrometeorites. A shadow shield at the opposite end of the reactor guards the space vehicle from radiation effects.

In operation, the powerplant could be located on the end of a boom which would extend from the space vehicle. As a safety precaution, prior to launch, the reactor could be separated into two halves, each subcritical. Then, during startup the two halves would be brought together into a critical state by mechanically positioning the end reflector. There would be no further need for moving parts.

The powerplant would be controlled by the negative temperature coefficient of the reactor.

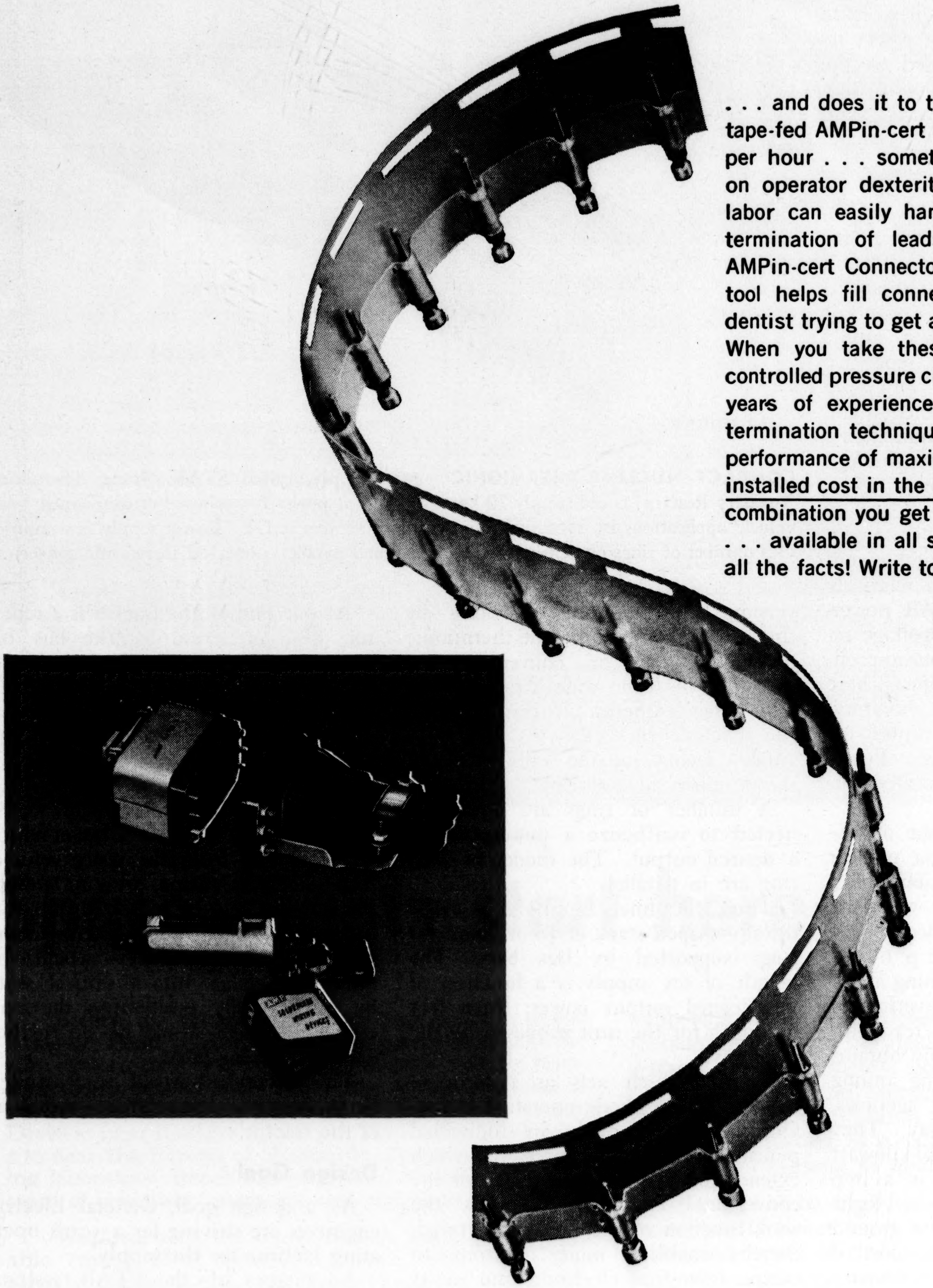
Design Goal

As a design goal, General Electric engineers are striving for a year's operating lifetime for the supply.

Advantages of the STAR system, General Electric says, are:

- **Reliability**—STAR would possess the inherent reliability of a system which does not need moving parts to maintain its operation.
- **Flexibility**—Fabricating single STAR converters and fuel elements as indi-

THIS TAPE PLAYS BACK THE SOUND OF MONEY...



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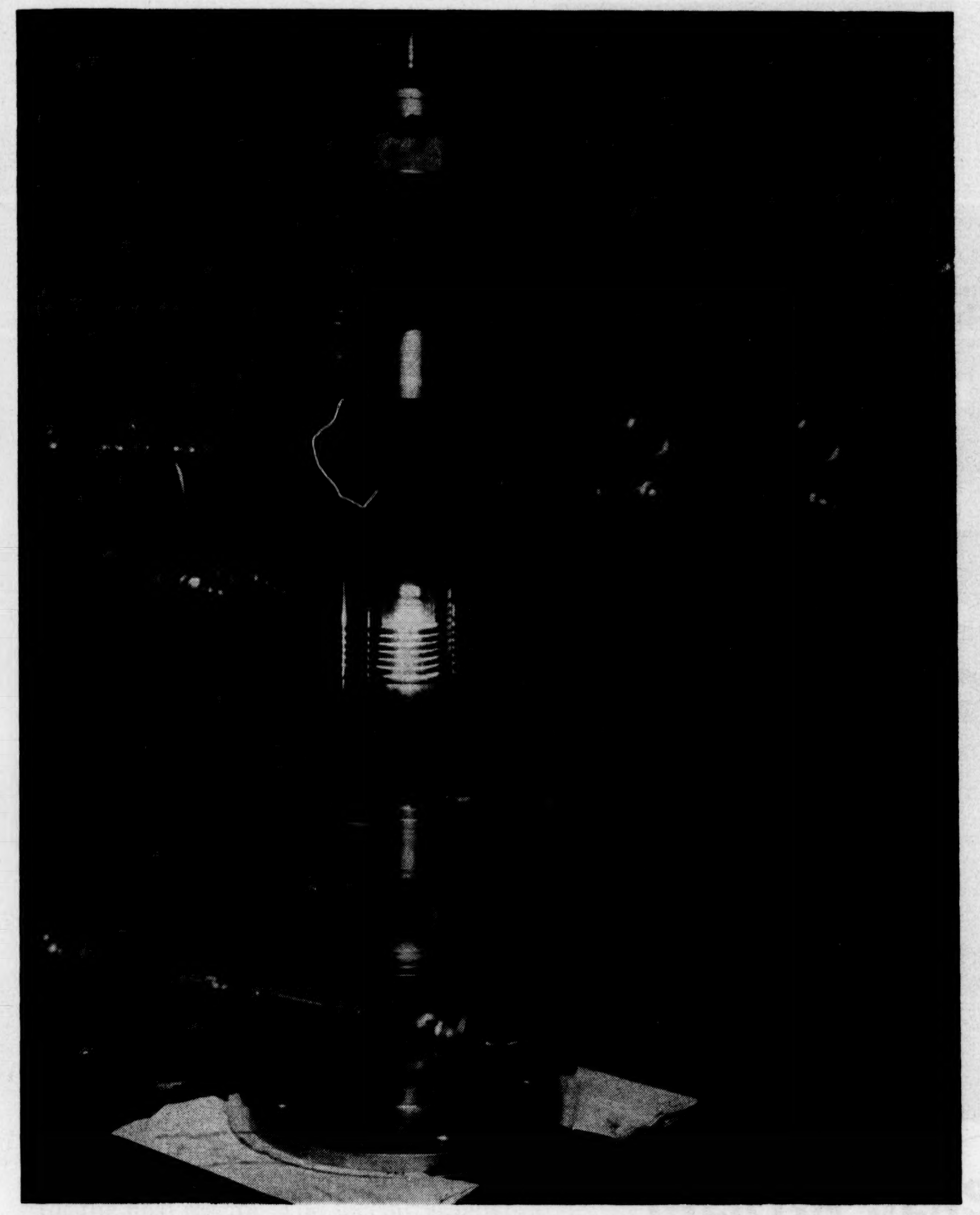

EXPERIMENT with plasma thermionic diode is conducted in the Vallecitos Atomic Laboratory of General Electric's Atomic Power Equipment Department in connection with a nuclear-thermionic powerplant for space vehicles.

vidual modules, then assembling them into rings to constitute the basic building elements of the powerplant, simplifies development and makes possible fabrication of higher power level units by adding more rings.

- **Freedom from orientation**—Orientation of the STAR powerplant in space is not critical because its operating temperature is only slightly affected by the sun's thermal radiation.
- **Low shielding weight**—By keeping the diameter of the reactor small the required shielding in the design was minimized. A graph of shield weight as a function of reactor diameter (assuming reactor power of 1,000 kilowatts and a 100-ft. separation), prepared here, indicates that a 3-in. increase in the diameter of the reactor would require an additional 500 lb. of shielding for manned missions.
- **Micrometeorite protection**—Should one of the exposed cesium gas reservoirs be punctured and the cesium escape, only a single converter in that ring would be open-circuited. Current for the ring would continue to flow because each converter in the ring is in parallel, thereby decreasing the output of the system by one converter's output.
- **Independence of zero gravity** conditions—The powerplant would be unaffected by free body environments, company engineers say, because the cesium is distributed in each converter, by a diffusion process that does not depend on accelerations. Surface tension will hold liquid cesium in the metal sponges mounted on the end of each tube.
- **Self-adjusting to varying loads**—The reactor will operate at essentially constant temperature, regardless of the load, determined by the cold clean reactivity of the reactor and the value of the temperature coefficient. Fuel burnup will be relatively small compared with the total uranium in the powerplant. The reactor can accept a load varying from open to short circuit without an external control system. During open circuit operation

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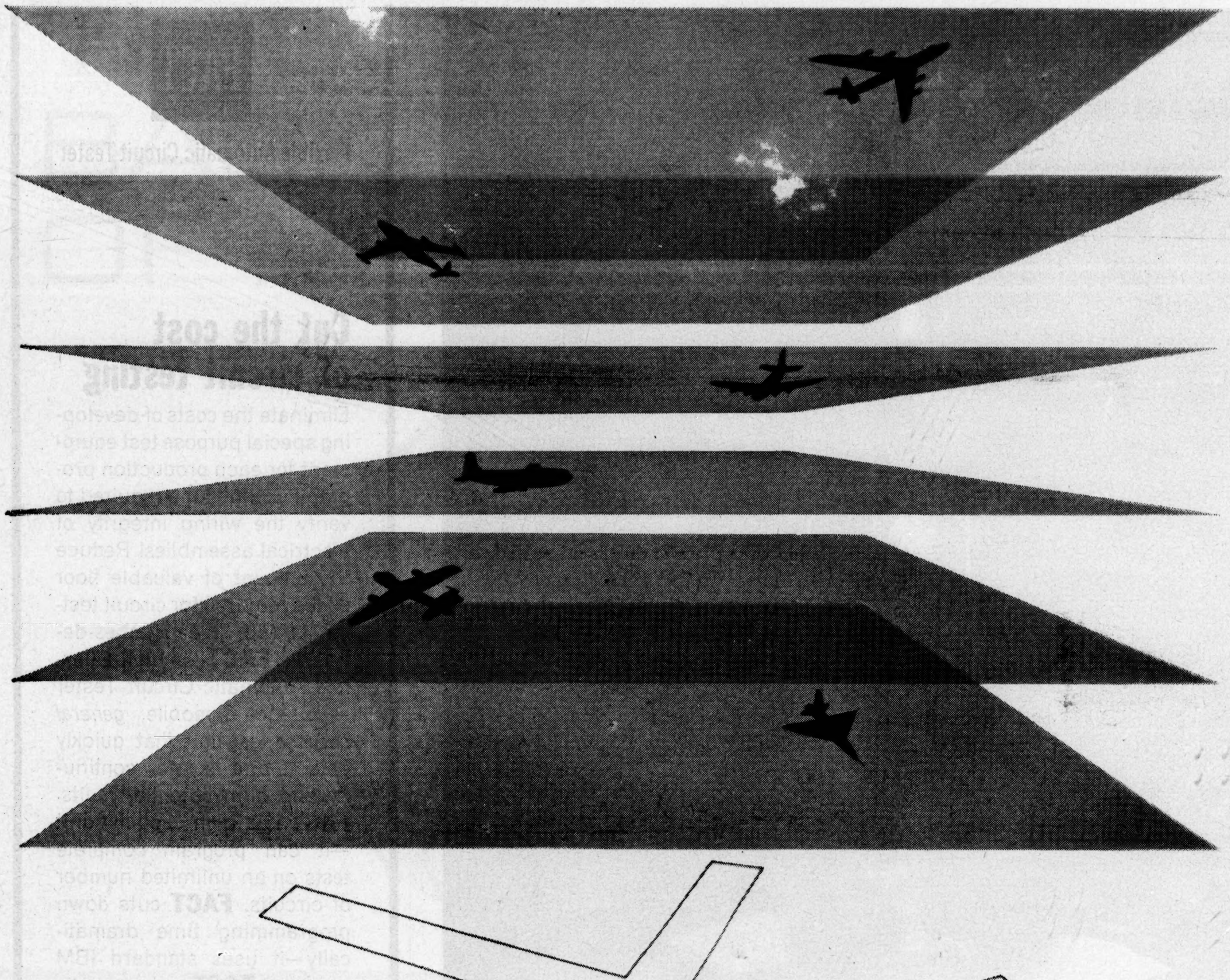
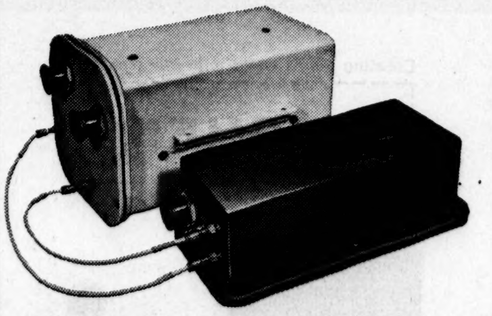


Cubic MOPTAR—key to jet age collision avoidance

Using only stationary antennas, with no moving parts, a single Cubic MOPTAR ground station (like the ones already in operation) can be expanded to provide 3-dimensional position data on as many as 400 aircraft. The expanded system can provide terminal and enroute surveillance, positive aircraft identification, conflict prediction, and navigation data. To avoid collisions, MOPTAR space-time information would be automatically and continuously processed, and potential-conflict data transmitted to the aircraft involved. MOPTAR, combining Cubic precision DME (Distance Measuring Equipment) and AME (Angle Measuring Equipment), was developed for the United States Air Force and the Federal Aviation Agency. For more information, write Dept. AW-107, Cubic Corporation, San Diego 11, California.



MOPTAR requires only this miniature transponder in each participating aircraft.

EMPLOYMENT OPPORTUNITIES—
Many challenging Space-Age projects
at Cubic invite inquiries from
experienced engineers and scientists.

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heat is transferred from the fuel by heat conduction and radiation losses. When current flows, heat is transferred from the cathode to the anode by electron cooling. While this might tend to drop cathode temperature, resulting in a fuel temperature drop, the reactor temperature would resume its original level after the reactor increases power as a result of the positive reactivity effect caused by the fuel temperature drop.

- **Ground testing**—The powerplant can be tested in a nuclear test facility by mounting the reactor in a vacuum can.

General Electric engineers compiled a summary of projected powerplant performance characteristics based on three levels of converter technology. The first of these calculations is based on laboratory experiments completed or in process; the second or prototype level on an estimate of the increase in thermionic technology expected by the time the prototype powerplant is constructed; while the final set of performance figures presumes use of advanced technology resulting from a vigorous development program continuing through launch qualification of the powerplant.

In each case, the weight (1,300 lb.) and general physical dimensions (36 in. long, 13 in. diameter) are identical. But the ability to operate at higher temperatures, largely made possible with improved materials, boosts the output power; thus reducing the specific weight (weight per kilowatt) of the system. For the three cases cited above, the output power increases from 13 to 20 kilowatts and finally to 70 kilowatts for the final reactor. The specific weight for the three respective cases would be 100, 60 and 20 lb./kilowatt. Individual thermionic converters of 10% efficiency are assumed throughout (although converters with efficiencies up to 17% are a laboratory reality). Anticipated voltage output would be 24 to 28 v.

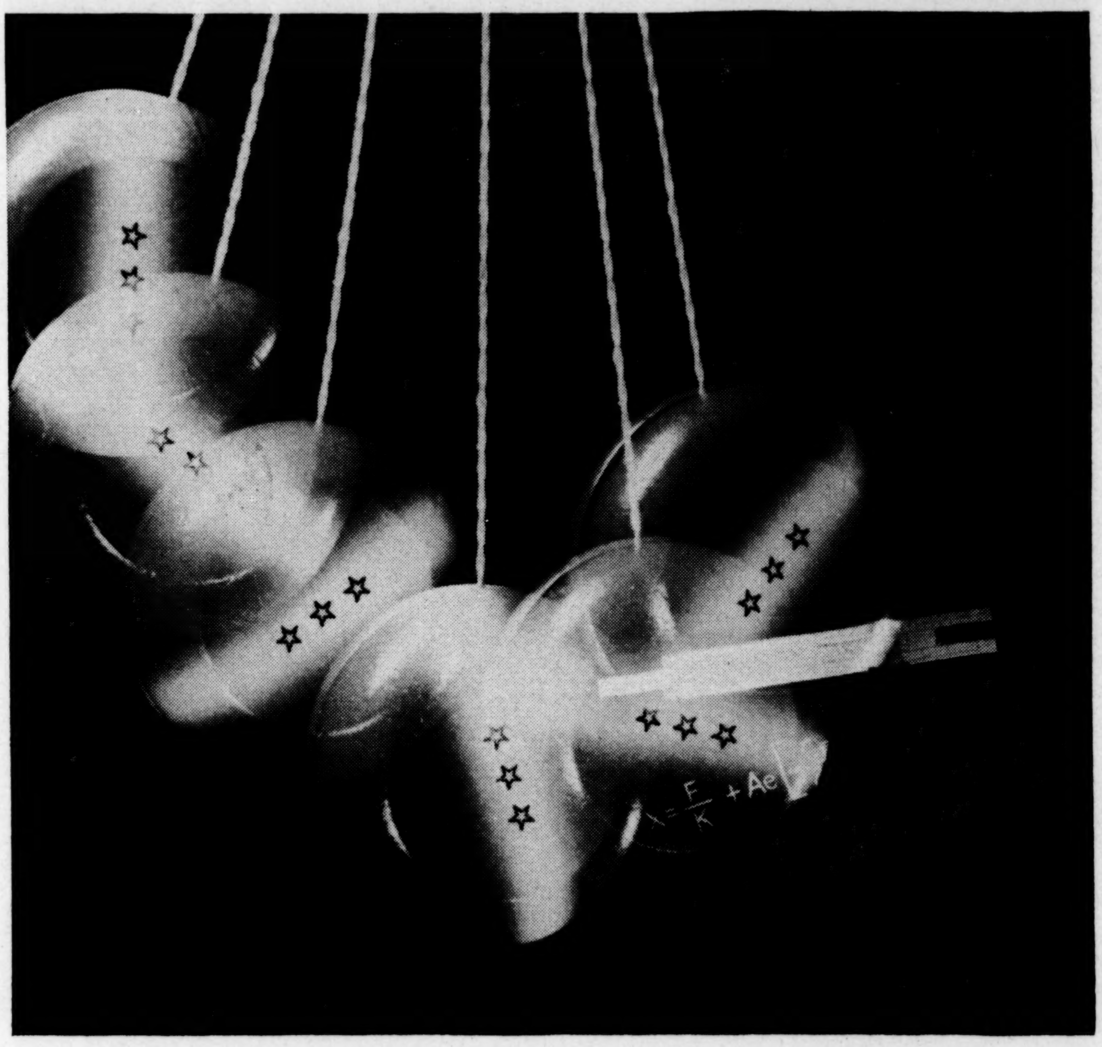
The STAR powerplant exploits the high temperatures provided by the nuclear source to obtain the high power outputs possible from thermionic converters at elevated temperatures. Fuel temperature in the final powerplant would be 2,430C.; cathode temperature, 2,230C; and reflector surface, 1,550C.

General Electric plans to use refractory materials, such as tungsten, tantalum, niobium and molybdenum in the powerplant construction. Fuel for the reactor would be uranium carbide-zirconium carbide solid solution.

The STAR powerplant is an outgrowth of an extensive program in thermionics both here and at other General Electric facilities. This research center's nuclear thermionic program embraces basic studies in physics, materials, applied converter development and systems efforts.

CAPABILITIES REPORT FROM
BENDIX PIONEER-CENTRAL

INERTIA SENSING



INERTIA SENSING EXPERIENCE KEYED TO YOUR NEEDS!

From basic inertia sensing problems to the most sophisticated needs, Bendix—during the past 40 years—has been establishing constantly higher and higher standards in designing and producing inertia sensing devices. Turn and Slip Indicators, Indicating Accelerometers, Vertical and Rate Switching Gyros, Registering Accelerometers, Single and Double Integrating Accelerometers are all part of the evolution that has made Pioneer-Central a leader in this field. Here are experience and capabilities that can meet *your* inertia sensing needs.

Other areas of outstanding Pioneer-Central capabilities include—Cryogenics, Pressure Sensing Instrumentation, Life Sciences, Fuel Management, and Sonic Energy Cleaning.

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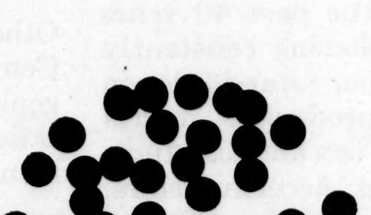
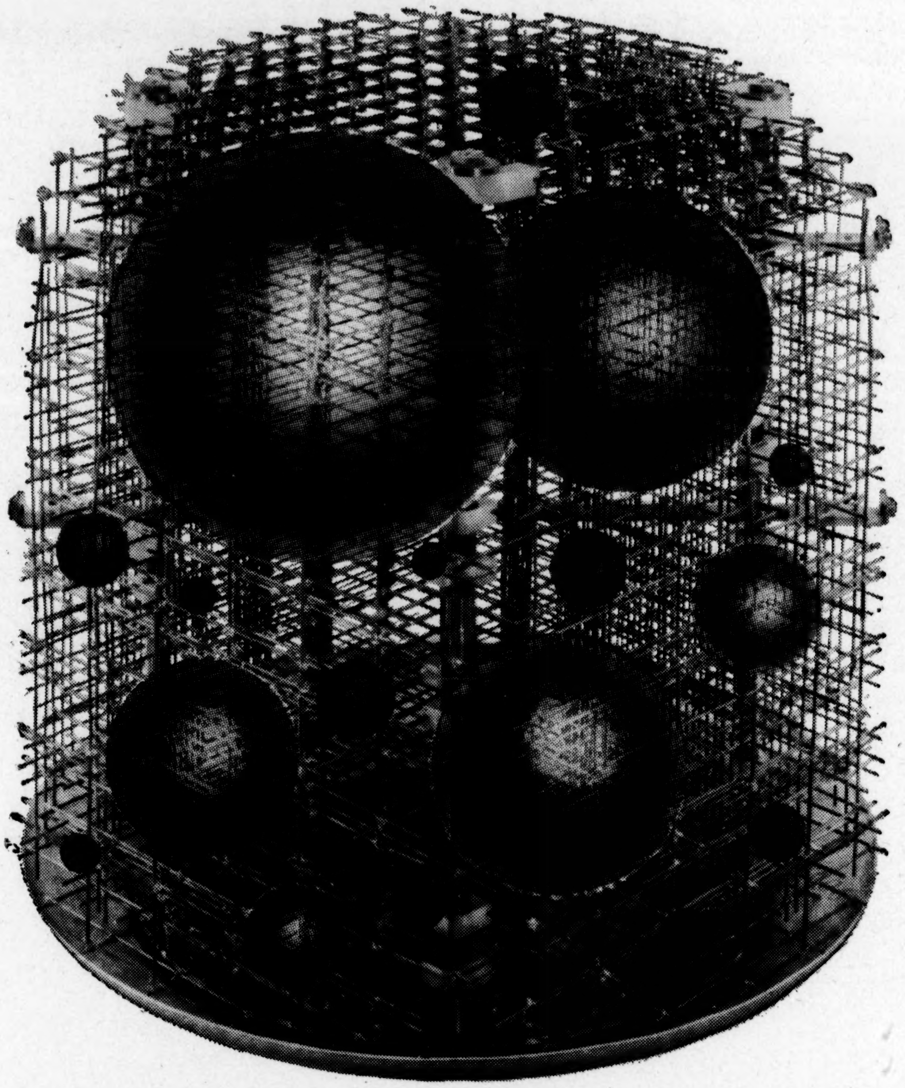


For the first time, atomic energy is being used in a space vehicle. Signals picked up from the latest Transit navigational satellite have been transmitted successfully by a radioisotope-fueled thermoelectric SNAP* generator. This is the beginning. The use of atomic energy — for propulsion as well as auxiliary power — is essential for man to range at will and for extended periods in Space. Atomic energy is the most compact source of power known. The device was designed, developed and built

for the U.S. Atomic Energy Commission by the Nuclear Division of The Martin Company. It provides electricity for instrumentation and for two radio transmitters in Transit, a satellite developed for the U.S. Navy by the Applied Physics Laboratory of Johns Hopkins University. Capable of providing continuous power for many years, the generator's total output will be comparable to that of several thousand pounds of chemical batteries. *_Systems for Nuclear Auxiliary Power_

MARTIN



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whatever a liquid's state or attitude, whether still or in agitation, the volume indication is the same with the Liquidometer Matrix Liquid Quantity Gauge. A capacitor type measuring probe — intercellular in construction — is the heart of the system. In addition to actuating an indicator, output can be telemetered, used for control purposes, or fed into computers. Potential applications: measuring liquid oxygen for astronauts; gauging liquids in advanced rocket propulsion systems; all-attitude gauging of aircraft fuels. Technical details in Booklet 694.

In the design and production of advanced instrumentation — electronic and electromechanical — Liquidometer offers many widely demonstrated capabilities, plus the talent and the willingness to pioneer. We welcome the opportunity to apply these qualifications, and our 40 years of experience, to your instrumentation requirements. Write for our capabilities brochure.

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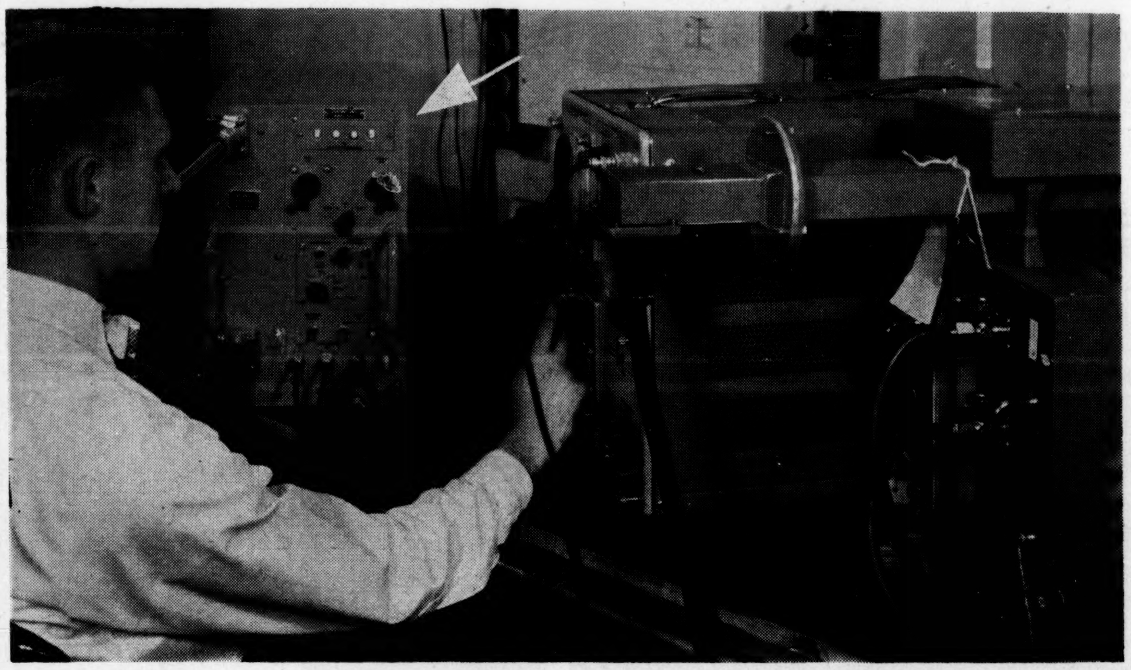


INCREMENTAL power spectrum analyzer (arrow), developed by Hallicrafters for testing ECM equipment and microwave tubes, provides continuous display of average power levels in 10-mc. increments over a band of 1,250 mc. at S-band, with high accuracy.

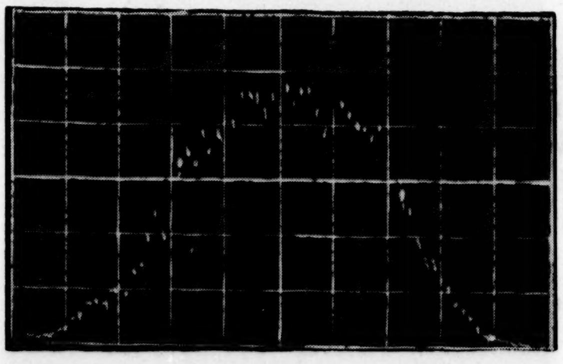
Device Checks ECM Performance

New device for evaluating performance of electronic countermeasures (ECM) equipment, for electromagnetic reconnaissance and for laboratory testing of microwave power tubes, has been developed by The Hallicrafters Co., Chicago.

The new instrument, called an incremental power spectrum analyzer, provides a continuous and instantaneous display of microwave average power levels, measured in increments of 10 mc. over a band of 1,250 mc. The direct readings of RF power and frequency are made with an accuracy previously obtainable only by time-consuming point-by-point measurements, according to Hallicrafters.

The first model to become available commercially covers the frequencies from 2,400 mc. to 3,650 mc. (S-band). A similar analyzer for L-band will be ready soon, and company expects to bring out additional models to cover the spectrum from 50 mc. to 12,400 mc., it says.

The analyzer contains 125 fixed-tuned narrow-band (10 mc.) crystal video receivers. The output from each is integrated to give a d. c. signal proportional to the time-average of RF power being received in that particular portion of the spectrum. The output signal from each of the 125 receivers is sampled sequentially 30 times per second by a high-speed commutator. Its output is applied to the vertical deflection amplifier of an oscilloscope whose sweep frequency is synchronized to the commutator.



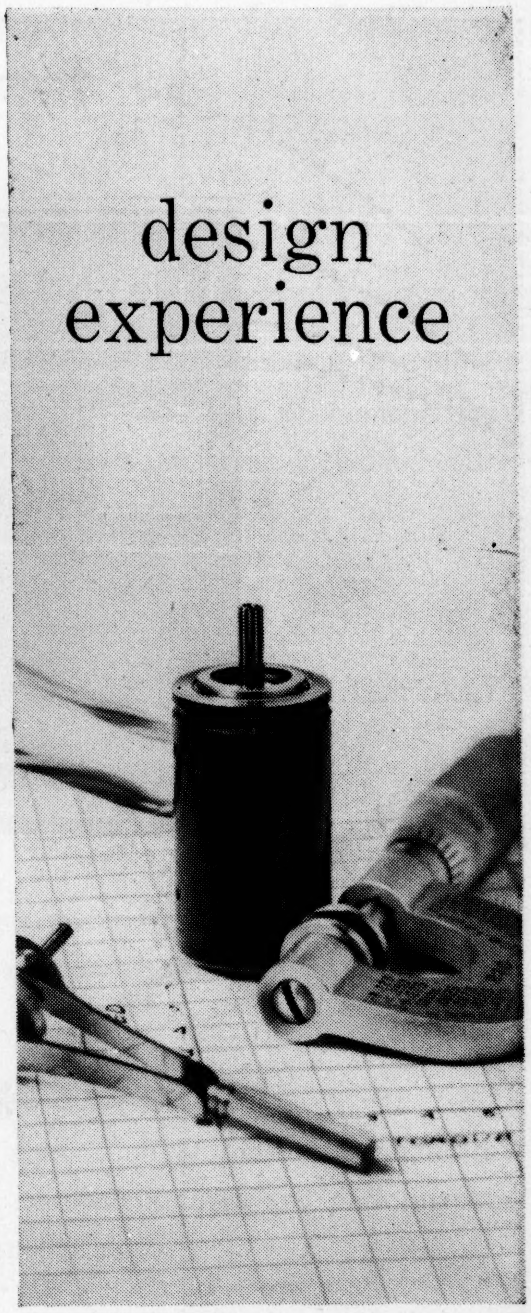
DISPLAY is of average power vs. frequency obtained by use of new spectrum analyzer. It was created by FM noise modulation of a voltage-tunable magnetron.

The display on the oscilloscope consists of 125 dots, which form a "dotted" spectrum-power distribution curve across the scope face. The height of any dot is proportional to the average RF power received at that particular 10-mc. portion of the spectrum, while its horizontal position indicates its approximate center frequency.

Because of the difficulty of visually scaling off the precise frequency of any single dot among the 125 on a small scope face, Hallicrafters provides two frequency markers in the new analyzer. These produce two bright-pip markers which, when superimposed upon any two of the displayed dots, read out their precise center frequencies on digital display tubes.

Hallicrafters says the new analyzer measures RF power level to an accuracy of within 10% over the entire band, while the frequency resolution is within 5 mc. for RF signal input power levels in the range of 0.5 to 50 watts per megacycle.

The incremental power spectrum analyzer originally was developed for preflight testing and in-flight monitoring of ECM transmitters to measure the power distribution of jamming signals, company says. (Hallicrafters is one of the major suppliers of ECM equipment to the Air Force.) The previously used superheterodyne spectrum analyzers did not have sufficient power linearity for such purposes and required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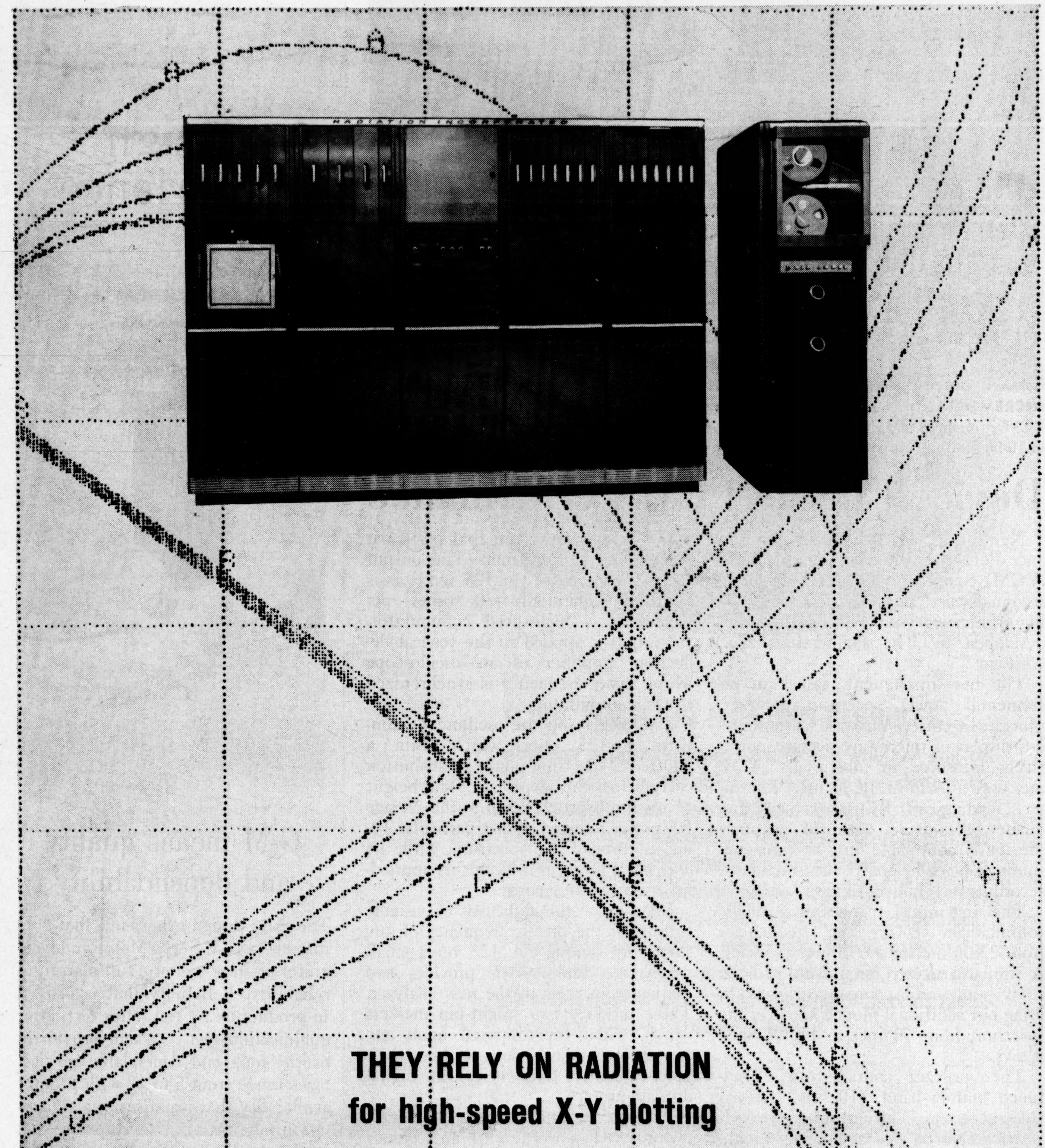

This X-Y Plotter, designed and built by Radiation for Kirtland AFB, plots five variables graphically against a selectable fifth variable from magnetic tapes generated by digital computer. It also provides identifying notations and text in alpha-numeric characters—at a speed of 50 data points per second.

Radiation engineers achieved a number of technological advances with the Plotter. For example: this highly automated equipment provides quick selection, independent scaling and zero-shifting for each variable. It can reproduce an unlimited number of report-quality copies of the plot. Advantages of the system are inherent digital accuracy, savings in time and labor, and simplified analysis of significant data.

The X-Y Plotter illustrates Radiation's ability to design, engineer and build advanced electronic systems for defense and industry. Perhaps you can take advantage of this unusual capability. We'll gladly send more information and a copy of our "Capabilities Report." Radiation Incorporated, Dept. AW-7, Melbourne, Florida.

All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

RADIATION
INCORPORATED

point-by-point procedures which were too slow, according to the company.

The new analyzer also is expected to be useful for electronic counter-countermeasure applications. For example, a radar operator can use it to determine which frequencies in the spectrum are not being jammed by an enemy in order to know where to shift the radar's operating frequency to avoid jamming.

The new analyzer is available in standard aircraft equipment case for military use, or in a commercial-type enclosure. Device measures $10\frac{1}{4}$ x $15\frac{1}{4}$ x $21\frac{1}{2}$ in., weighs 98 lb. and draws 1.75 amp. of 115 v., 60 cps. power. Price of the unit is $14,800 f. o. b. Chicago with delivery in 60 days, according to Hallicrafters.

Novel Semiconductor Transducer Devised

Semiconductor strain-gage pressure transducer with a 5-volt output, which is temperature compensated over the temperature range of −65F to 250F, has been developed by Dynisco Division of American Brake Shoe Co., Cambridge, Mass.

The high output is achieved directly without amplifiers.

The company says it has been able to achieve compensation over the wide temperature range, without sacrificing high output voltage.

Dynisco says its new PT-500 pressure transducers are accurate to within 1% of full scale, relative to room temperature static calibration curves, taking into account all sources of instrument error —repeatability, non-linearity, hysteresis and the combined effect of sensitivity

HIGH SENSITIVITY pressure transducer, using semiconductor strain-gage, has output of 5 volts, gage factor of 100 and is compensated over temperature range of −65F to 250F using new technique.

The Lincoln Laboratory program for ballistic missile range measurements and penetration research includes:

EXPERIMENTAL RESEARCH

Measurements and analysis of ICBM flight phenomena for discrimination and for decoy design purposes, including optical, aerodynamic and RF effects.

SYSTEM ANALYSIS

Studies to apply research findings to advance the technology of ICBM and AICBM systems.

INSTRUMENTATION ENGINEERING

Designing radar, optical and telemetry equipment with which to measure ICBM flight effects under actual range conditions.

RADAR SYSTEMS RESEARCH

Extending the theory and application of radar techniques to problems of discrimination, countermeasures and performance in a dense-target environment.

HYPERSONIC AERODYNAMICS

Study of the flow-fields around re-entering bodies for various body designs and flight conditions. Excellent computer facilities available.

RADAR PHYSICS

Theoretical and experimental studies in radar back-scattering. Interaction of RF radiation with plasmas.

A more complete description of the Laboratory's work will be sent to you upon request.

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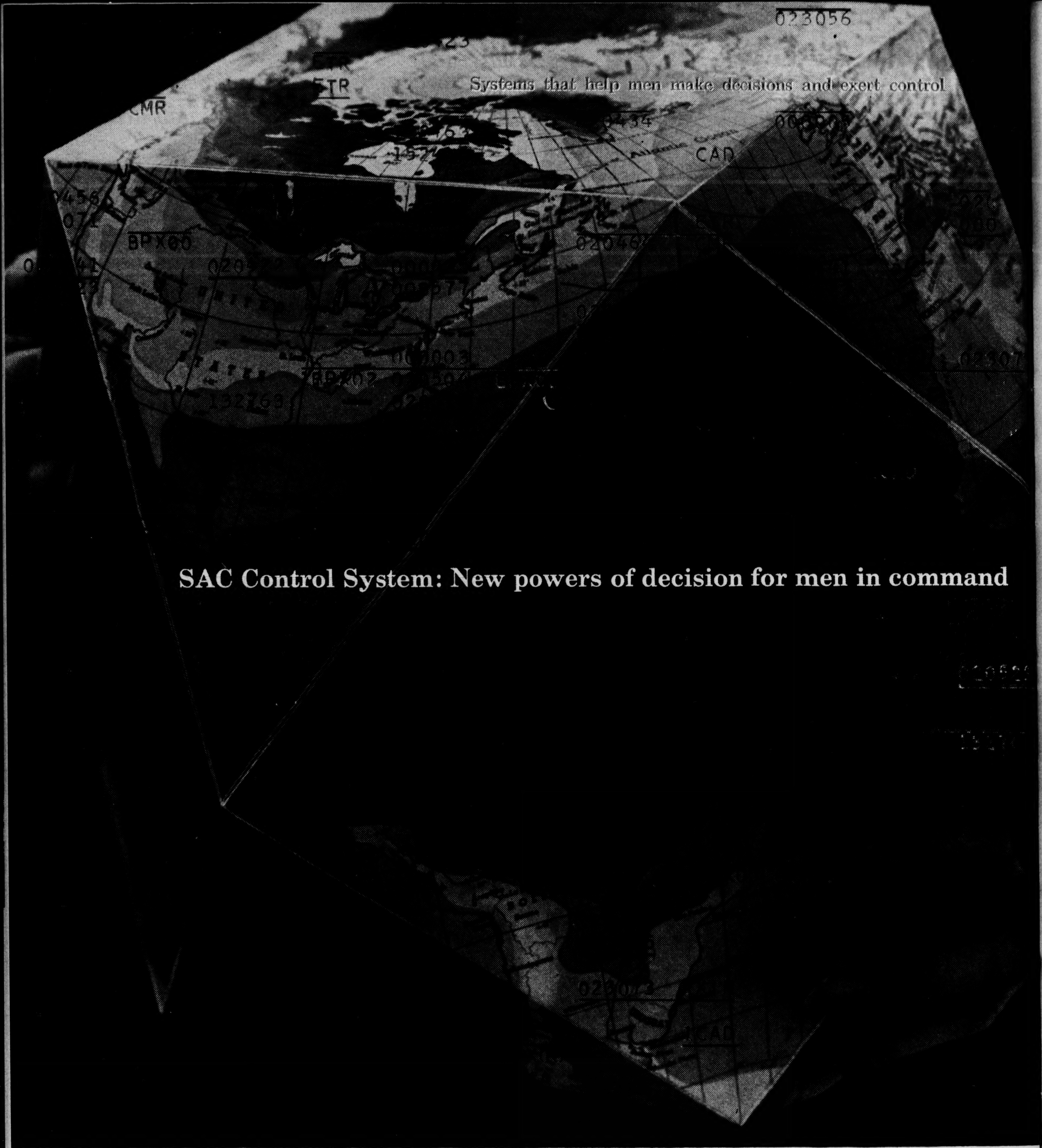
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This world-wide communication network will help Strategic Air Force leaders exercise command and control almost in response to events of the moment. Yet the forces involved are dispersed throughout the world, the volume and complexity of information unprecedented. ¶ The SAC Control System will be a product of the new technology of automated information processing assistance. We have helped create this new technology, beginning with our work on SAGE. In projects such as SAACS and SAGE, we perform system analysis, information processing system design, and training of personnel in system use. And as a continuing effort, we carry on research into future generations of these control systems. Scientists and engineers interested in joining an interdisciplinary approach to system development are invited to inquire about our rapidly expanding efforts. Positions are open for Operations Research Scientists, Computer Programmers, Engineers, Human Factors Scientists at our Santa Monica, California, Lexington, Massachusetts, Washington, D. C., and Paramus, New Jersey facilities. Please address Mr. R. L. Obrey, SDC, 2432 Colorado Avenue, Santa Monica, California. All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

SDC
SYSTEM
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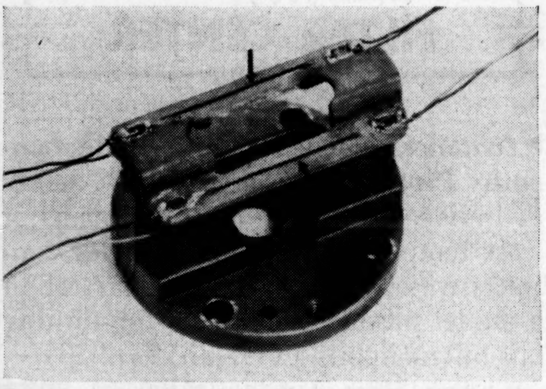
The globe shown is the Dymaxion projection by R. Buckminster Fuller. It depicts the spherical world as a flat surface with a minimum of distortion.



FOUR SILICON whisker strain gage elements, 0.001 in. in diameter form heart of new transducer. Two are hidden on underneath side of the unit.

change and zero shift with temperature.

Company currently is offering the new PT-500 semiconductor strain-gage transducers to gage absolute and differential pressure ranges of 0-10, 0-50, 0-500 and 0-1,000 psi. Transducers for the range of 0-1 and 0-5,000 psi. are under development.

Dynisco says it started its transducer development program following first disclosure in AVIATION WEEK (Feb. 1, 1960, p. 74) of the new approach to high-sensitivity strain gages using thin whiskers of semiconductor material developed by Electro-Optical Systems. The article pointed out that the new semiconductor devices appeared to have an ultimate gage factor (measure of sensitivity) of about 175, compared with a figure of 2½ for conventional strain gages. But it also noted that there were temperature compensation problems because semiconductors themselves are temperature-sensitive.

Dynisco says it has devised a better means of temperature compensation than semiconductor doping or use of thermistors, both of which reduce strain gage sensitivity.

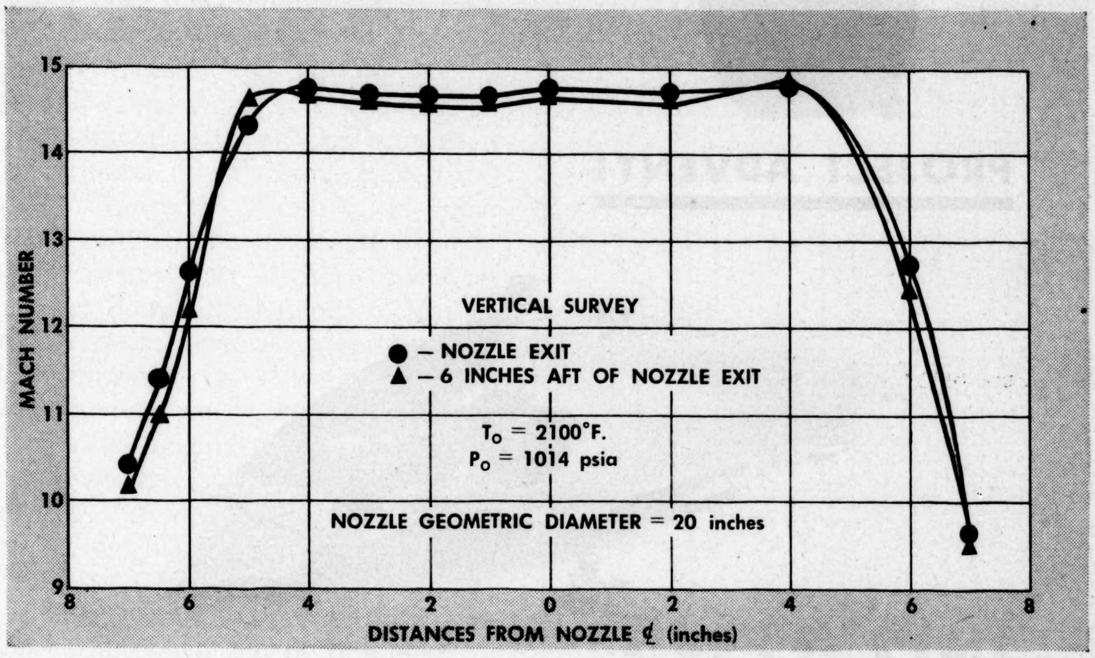
In the new pressure transducers, Dynisco uses four silicon whiskers, each approximately 0.001 in. in diameter, connected in a bridge circuit which is excited with 25 volts. The individual whiskers are bonded to a constant-moment beam which is linked to the pressure-sensitive element in the transducer. As the element is deflected by pressure, the resistance of the whiskers is altered. Company says it is obtaining gage factors of more than 100.

The new transducer, like others using strain gages, requires the use of a regulated, ungrounded 28-v. a.c. or d.c. source. Company says it produces a d.c.-to-d.c. converter which provides regulated d.c. excitation that is isolated from the power source.

Company says that it has delivered prototype models to Hercules Powder Co. and Douglas for evaluation. In quantity, the new transducer sells for $500, a company spokesman says. Dynisco's address is 42 Carleton St., Cambridge 42, Mass.

MACH 14.7 DATA

The graph below presents calibration data at two stations downstream of the nozzle in the new **FLUIDYNE** Hypersonic Flight Simulation Facility.



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Nike Zeus, Saturn, and Dynasoar programs have been run or are scheduled.

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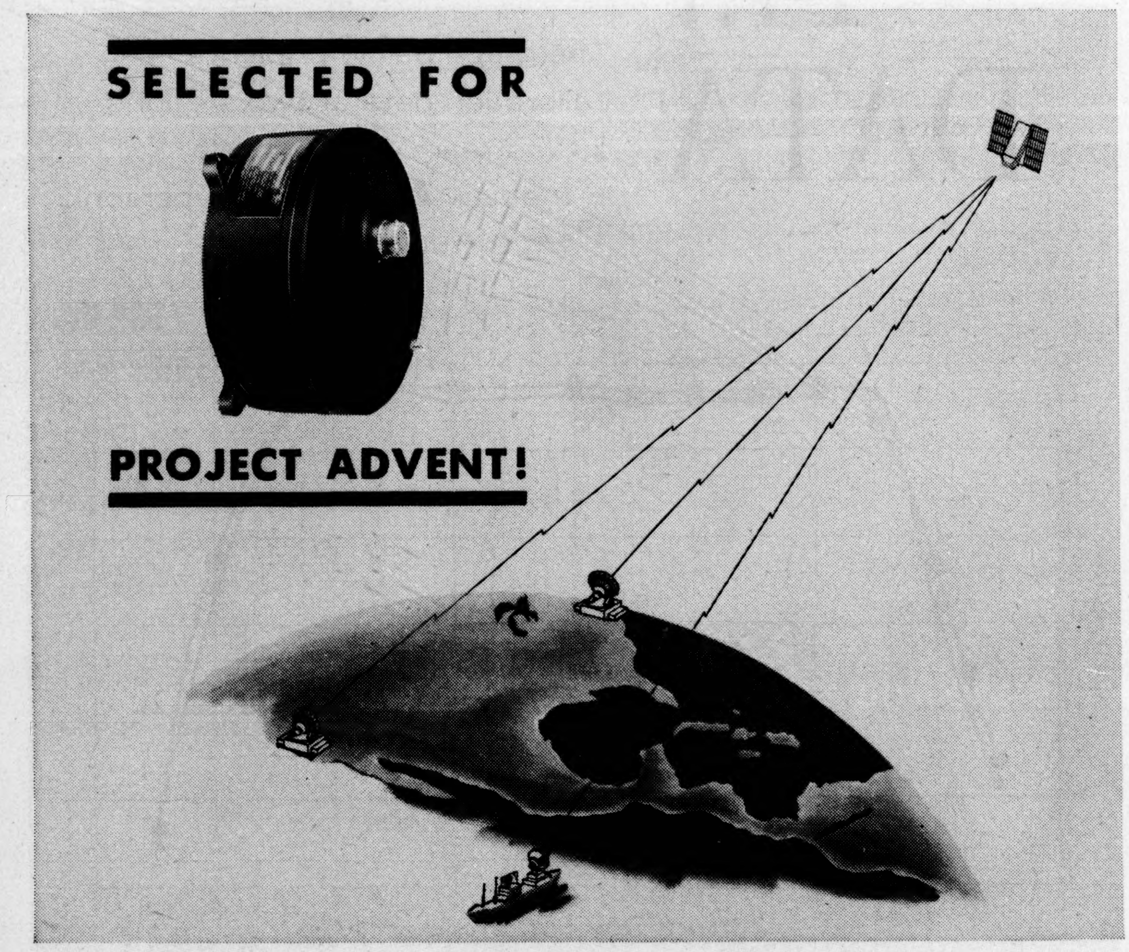
ENGINEERING
REPORT
ON BENDIX COMPONENTS



BENDIX REACTION WHEEL FOR SATELLITE CONTROL AND STABILIZATION

Precision reaction wheels developed at Bendix meet requirements for attitude control of space vehicles and satellites. For example, these wheels will be used for Project ADVENT—advanced Army research program which will use satellites as relay stations for global communications.

Since reaction torque is directly proportional to applied voltage, the reaction wheel provides a means for proportional control of vehicle attitude. An integral tachometer senses wheel speed and direction of rotation.

Several wheel configurations are now available, and the basic design concept offers flexibility to meet still broader requirements. Individual wheels can be tailored to specific voltage, torque, inertia, and momentum storage requirements.

ADVANTAGES AND FEATURES
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• Low friction • Flexible design
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FILTER CENTER

▶ **Avionics Facility Drops Microcircuitry Program**—Naval Avionics Facility at Indianapolis has abandoned plans at least temporarily for the award of contracts which were expected to result in a model production facility for turning out microcircuits (AW Jan. 9, p. 23).

▶ **Microcircuits for Army**—Servomechanism's Research Division will deposit microcircuits on 0.3 in. square wafers for the Army's micromodule program under a $77,000 research and development contract from the Signal Corps. Company has deposited complete circuits in areas this small using uncased or micro-transistors and diodes as active elements. In the past year, RCA, Army's prime contractor on the micromodule program, has stressed ability of micromodule wafers to accommodate complete circuits, fabricated by many advanced techniques, as well as the individual components for which they were originally intended.

▶ **PSI Tightens Belt**—Pacific Semiconductors, Inc., has made a number of adjustments in the size of its staff and in the evaluation of its inventory to place itself in a better position to compete in the pricing war which is engulfing the semiconductor industry. Company has reassessed its inventory, resulting in a write down amounting to what it estimates as $3 million—a reflection of sharply falling semiconductor prices. Cutbacks and normal attrition in PSI's production, reliability, research and development staffs since January have cut the company's work force by approximately 20 to 30. These measures were necessitated by industry pricing drops and a stretchout in company's diode production contracts for the Minuteman ICBM. Pacific's sales volume of about $20 million in 1960 places it among the top 10 semiconductor device firms.

▶ **Studying Oceans**—Applied oceanography group was recently set up at the Scripps Institution of Oceanography, La Jolla, Calif., to conduct Navy-sponsored study of physical, chemical and biological phenomena in the surface and near-surface of a square mile of ocean, according to Office of Naval Research's Naval Research Reviews. An aim of the program is to discover physical basis of several oceanographic phenomena that are not now understood.

▶ **Solar Cells From Dendritic Growths**—Study of high efficiency solar cells made from crystals grown by its dendritic growth process (AW Apr. 27, 1959, p. 54) is being conducted by Westinghouse under Army Signal Corps sponsorship.

▶ **Westinghouse Tube Favored for Bambi**—Westinghouse's "thermocon," a TV iconoscope tube which is sensitive in the infrared rather than visible light regions, reportedly will be employed in orbiting satellites envisioned in the present studies of satellite-borne ICBM defensive systems, known as Project Bambi (ballistic missile boost intercept).

▶ **Digital Pressure Transducer Requirement**—USAF's Aeronautical Systems Division may soon issue a request for proposals for development of a direct binary output pressure transducer—a transducer which can provide binary outputs as a function of applied pressure without the need for conventional analog-to-digital converters. Similar request, put out by Edwards Air Force Base (AW Feb. 6, p. 79), has been canceled in view of the impending ASD program.

▶ **Minuteman Component Competition**—Competition to select an alternate source for the magnetic drum which is used in the guidance computer of the Minuteman ICBM is being held by Autonetics, associate prime contractor for the ICBM. Until now, the computer drums were made by Autonetics. Other alternate or second component source awards, for transistors and diodes, may be made by late summer.

▶ **USAF Funds New Microelectronic Program** — Motorola will conduct USAF's new three-year microelectronic program (AW Jan. 23 p. 97) which will attempt to combine and integrate the many promising techniques of thin film technology, epitaxial semiconductor growth and integrated circuit technology. The $1.5-million program is being sponsored by the Aeronautical System Division's Electronic Technology Laboratories.

▶ **Scratch One Breakthrough**—Unusually high figure of merit for a rare earth thermoelectric material (gadolinium selenide), reported last year by a scientist with Nuclear Corp. of America, has not been verified by independent measurements. It was claimed that gadolinium selenide had a figure of merit of 0.045/deg. at 800C—50 times better than any previously known material for thermoelectric power generation—a substantial step forward in thermoelectric conversion. Material is still considered promising, as it had been before Nuclear's announcement, but is not appreciably better than any other competitive materials.

▶ **Transistor Price War Takes Toll**—Latest figures released by Electronic Industries Assn. indicate that dollar volume for transistor sales for first four months of this year increased only about 4.4% whereas sales in units rose by nearly 36%, reflecting continuing decline in transistor prices. Transistor unit sales declined in April compared with March, as they had last year.

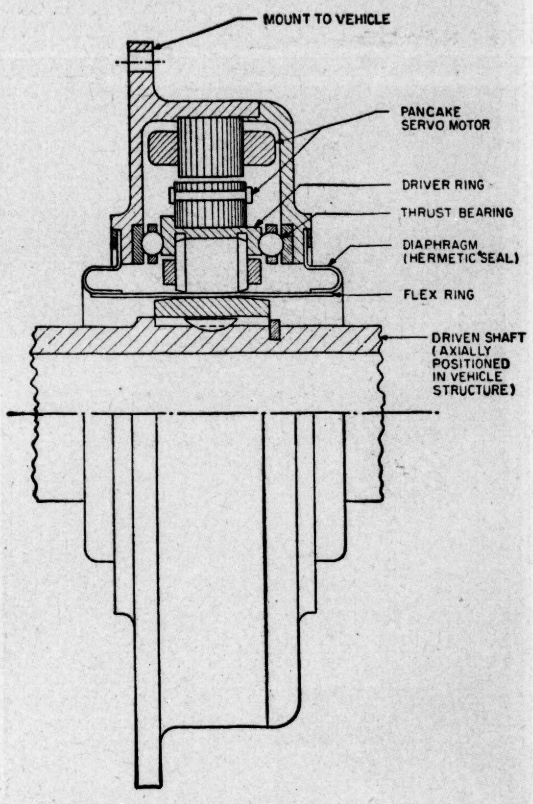
▶ **Adaptive Bandwidth Compression Study**—Technique of analyzing outputs of sensors and signal conditioners of airborne telemetry system in a small digital computer, transmitting only non-redundant data and then reconstituting all of the original data on the ground is being studied by Packard Bell Electronics. Computer decision on what will be sent will be made on basis of signal changes and higher orders of changes. Bandwidth-saving technique would require special purpose computer, perhaps 8 lb. in weight and occupying about ½ cu. ft., to accommodate 250 channel telemetry system, according to company scientists. The study, funded by NASA's George C. Marshall Space Flight Center, calls for simulating operation of airborne computer using a 7090 computer to determine how much compression can be obtained.

▶ **Electronic Components Sales Rise**—U. S. manufacturers sold $3.4 billion in electronic components during 1960, an increase of more than 10% over 1959, according to figures released by the Commerce Department's Business and Defense Services Administration. Nearly 40% of the 1960 total went into military end-use equipment, Commerce Department says. All categories of component sales for 1960 were above the 1959 figures except for receiving tubes which declined 7%.

▶ **Damped Printed Circuit Boards Developed**—Printed circuit boards constructed with integral damping to minimize resonance under shock and vibration conditions, have been developed by Lord Manufacturing Co. New Dyna-damp boards, now under evaluation by several avionic equipment manufacturers, are described in Bulletin 719. Company's address: 1635 W. 12th St., Erie, Pa.

▶ **USAF Buys Martin Racep**—Air Force's Electronic Systems Division has purchased six units of the new Martin digital-voice communication system, known as Random Access and Correlation for Extended Performance, or Racep for short. For description of Martin's new spread-spectrum communication system see Aviation Week, June 19, p. 87.

ENGINEERING
REPORT
ON OTHER BENDIX COMPONENT PACKAGES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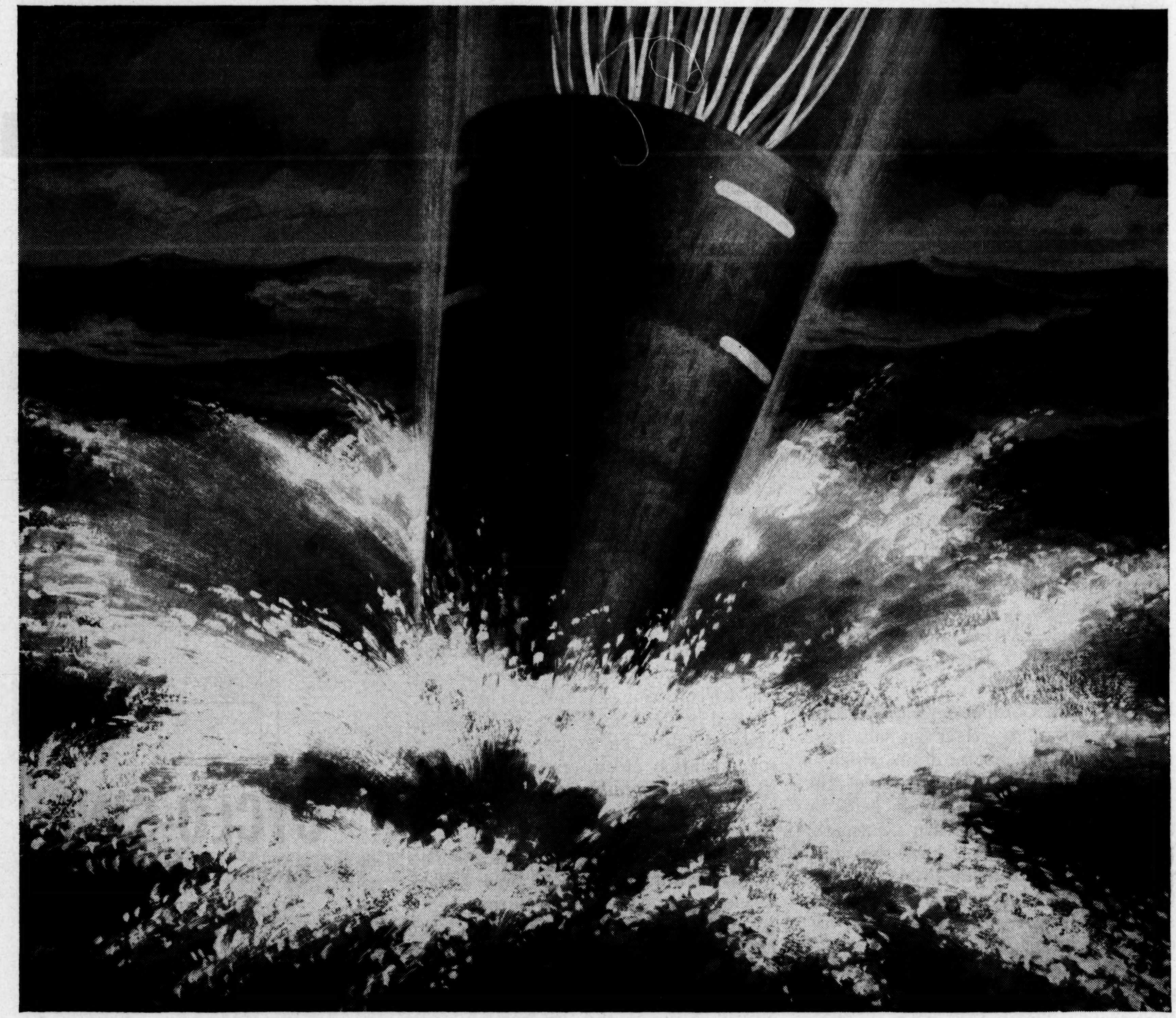


How the ocean grew "ears" to pinpoint missile shots

A quarter of the world away from its launching pad an experimental missile nose cone splashes into the ocean.

How close has it come to the target?

Where can it be found, recovered and studied?

To answer these questions quickly and accurately, Bell Telephone scientists have developed a special system of deep-sea hydrophones—sensitive "ears" that hear underwater. Its name—the Missile Impact Locating System, or MILS for short. MILS, produced by Western Electric, manufacturing and supply unit of the Bell System, involves two types of networks.

- One is a Long Distance network which monitors millions of square miles of ocean. The nose cone releases a small bomb which sinks and explodes at optimum depth for transmission of underwater sounds. Vibrations are picked up by hydrophones stationed at optimum depth and instantly carried by cables to ground stations. Since the vibrations take longer to reach some hydrophones than others, time differences are measured to compute the location of the nose cone.
- The other is a "bull's-eye" network which monitors a restricted target area. This network is so sensitive that no bomb is needed. It can detect the mere splash of an arriving nose cone and precisely fix its location.

MILS is now operating in both the Atlantic and the Pacific test ranges. It was installed by the U. S. Navy with technical assistance from Western Electric.

It's still another example of how the universe of sound—below the sea, above the earth, in outer space—is constantly being explored by the Bell Telephone System.

BELL TELEPHONE SYSTEM

AMERICAN TEL. & TEL. CO. / WESTERN ELECTRIC CO. / BELL TELEPHONE LABORATORIES / 21 OPERATING COMPANIES

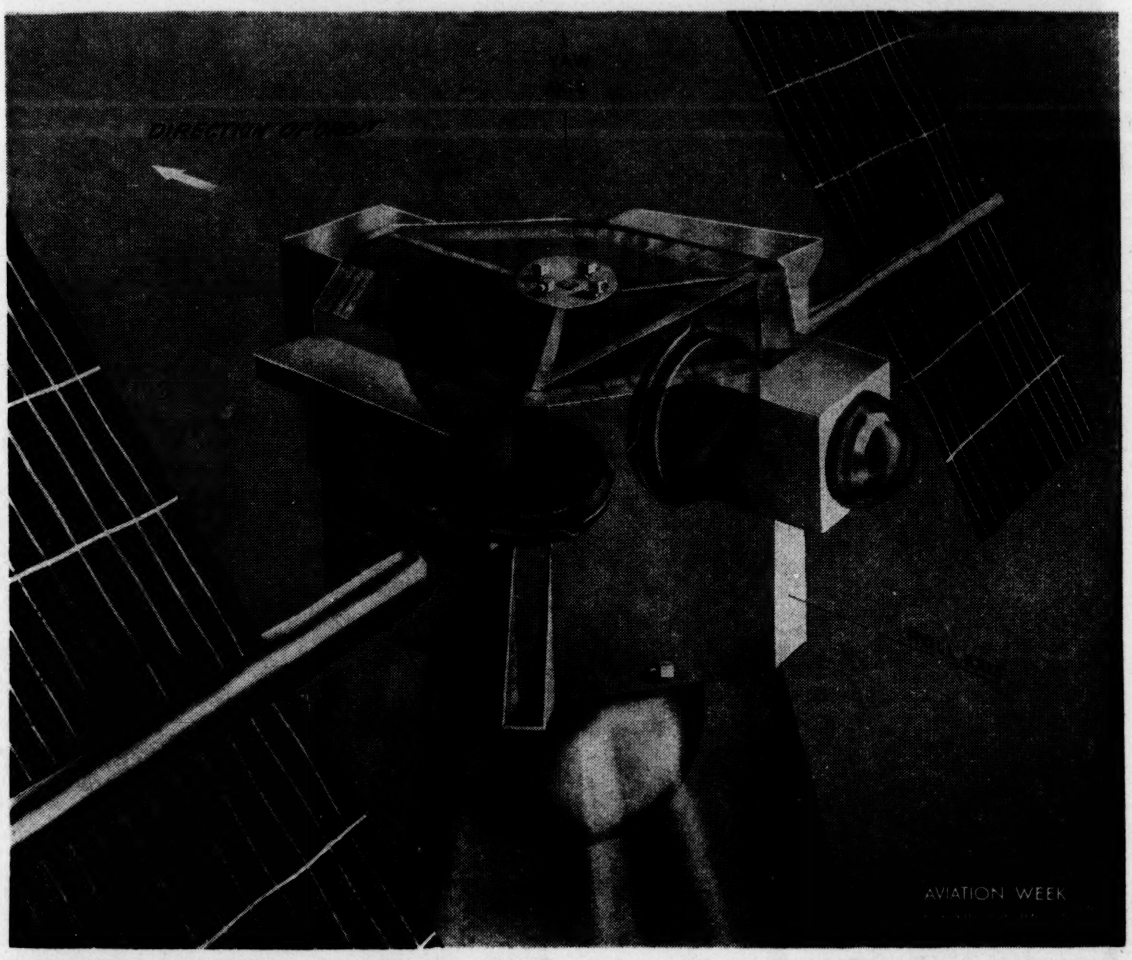
Nimbus Uses Wheels, Jets for Control

By George Alexander

Philadelphia—Polar-orbiting Nimbus meteorological satellite, with a stringent design objective of deviating less than one degree in any axis, will use a reaction-wheel and pneumatic control system to maintain its cameras in a constant earth-oriented attitude.

The attitude-control system, which also must suppress the instantaneous rate around any axis above .05 deg./sec., is being built by General Electric's Missile and Space Vehicle Department, Philadelphia, Pa., for the National Aeronautics and Space Administration's Goddard Space Flight Center and consists of these major assemblies:

- **Three flywheels,** one for each axis, are actually the externally mounted armatures of three small 32-pole a.c. motors.
- **Two infrared sensors,** with germanium flakes as the sensing elements.
- **Two sun sensors,** one for coarse orientation and the other to measure gyro accuracy.
- **Eight compressed-gas jets,** two for pitch, two for roll and four for yaw.
- **Small digital computer,** weighing 4 lb. and rated at 5-6 watts. It was designed especially by GE for the Nimbus control system.



ATTITUDE-CONTROL SYSTEM for Nimbus meteorological satellite features reaction wheels and compressed-gas jets to achieve stabilization within stringent design requirements of less-than-one-degree position deviation and rate of less than .05 deg./sec. around any axis. System is being built by General Electric-MSVD for NASA's Goddard Center.

Control System Sequence

Functioning of the control system begins 2 sec. after separation from the Thor-Agena B booster and follows this sequence:

One pitch jet, fed from a spherical tank located directly below the system's center of gravity, releases cold nitrogen for 20 sec. in an automatic, blind pitch-up maneuver. The IR scanners, situated 180 deg. apart along the line of direction, search fore and aft of the satellite for the horizons. Seeking a balance in the earth/space proportions seen by each, the scanners emit small voltages which are amplified and entered in the computer.

For roll correction, the computer compares the magnitude difference between the scanners and commands one of the roll jets, mounted atop the hexagonal-shaped unit, to release a burst of gas. Simultaneously, to correct pitch error, the computer takes only the signal received from the forward-looking sensor and activates either one of the pitch jets, also top-mounted. By this time, the satellite should be roughly vertical, within 3 deg. of the desired position along the pitch and roll axes and not rotating faster than .05 deg./sec. If so, the pneumatic system has accomplished coarse orientation and is shut down.

To bring Nimbus within 1-deg. along any axis, the computer now feeds the IR data through an amplifier to the appropriate flywheel. Each 5-in. diameter, 4.7-lb. wheel is spun up to a rpm. analogous to the input voltage and the reaction of the acceleration exerts a torque on the satellite body. Once the rpm. level has been reached, the input voltage effectively nulls the error signal and the satellite should stabilize in its corrected position. In actual operation, GE and NASA expect that slight overshoots may occur but that small additional corrections by the wheel will place the satellite right on line.

Each flywheel loop has a threshold detector, which serves two purposes: initially, it activates the pneumatic system when the position and rate error falls beyond the 3-deg., .05 deg./sec. dead band and, thereafter, monitors the tachometer on each wheel. Since the rpm.'s of the wheels are cumulative, the detector activates the jets to dump the wheels back to zero rpm., when the saturation point of 1,200 rpm. has been reached.

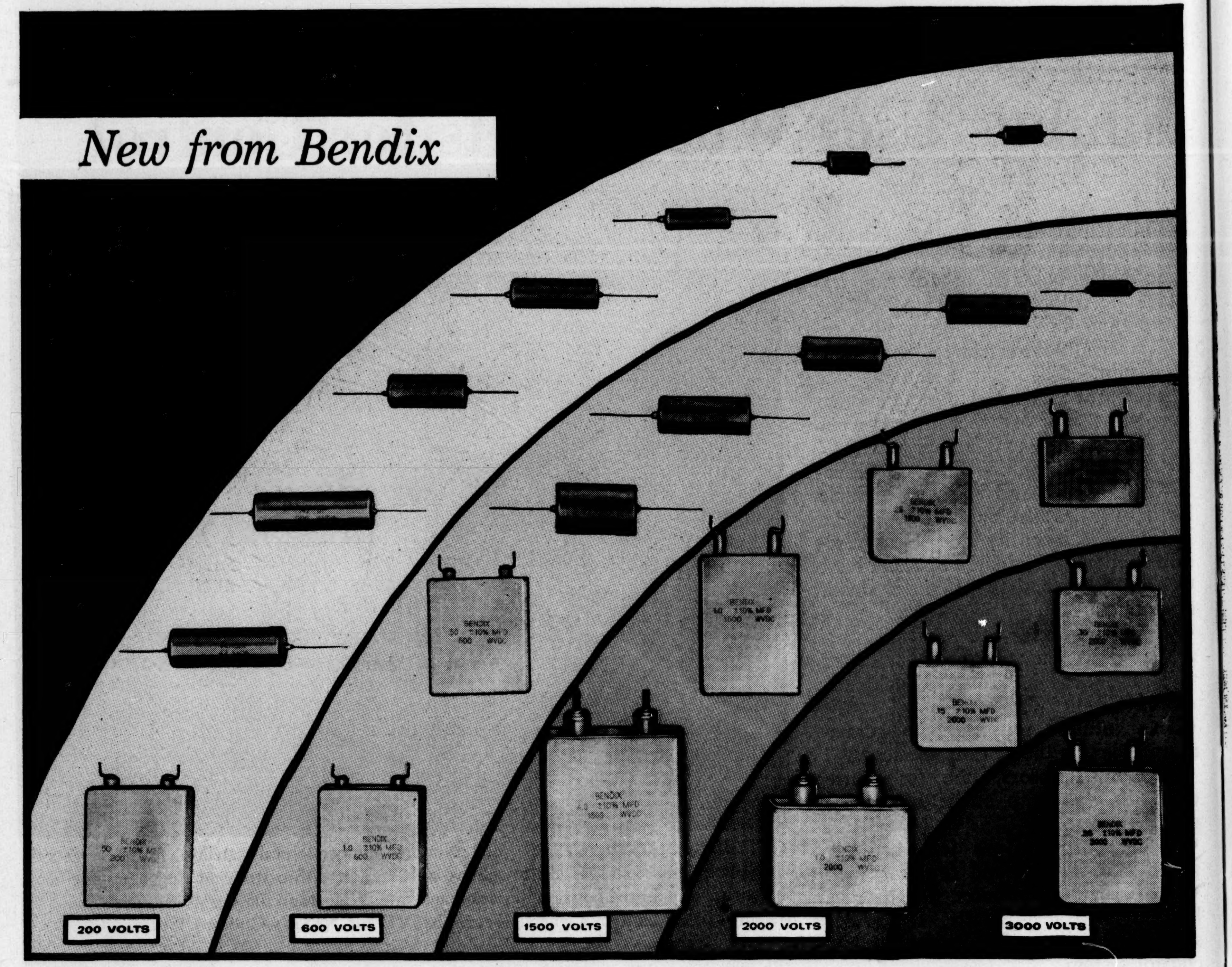
At 180 sec., the coarse sun sensor—an array of eight solar cells—locks on the sun and gradually brings the yaw deviation down to less than 3 deg., again at a rate not to exceed .05 deg./sec. When the error falls below this coarse level, an automatic switch transfers yaw control to a rate-integrating gyro which combines both the yaw and roll rates into a single signal for a torquer amplifier. For the next 180 sec., the fine yaw control flywheel is repeatedly spun up and dumped until the Nimbus is within its 1-deg., .05-deg./sec. design parameter.

Stability Achieved

At six minutes after separation, the Nimbus should be stable on all three axes and ready to turn on its videcon cameras (AW June 26, p. 27).

Solar paddles, which will probably draw 8-10 amp., are opened 2 sec. after separation from the booster. A sun sensor, mounted on the paddle shaft, provides inputs to a drive mechanism which rotates and maintains the paddles perpendicular to the sun's rays. During light periods, the paddles are designed to be sun-oriented to within 10 deg.

The system's fine sun sensor is used to check drift in the yaw gyro. A



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The new series is designed and manufactured to a Bendix specification which is patterned after the high reliability specification MIL-C-14157B, proposed.

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E-200 CHARACTERISTICS: • Wound mica papers • Solid impregnants • Exceptional stability • High insulation resistance • Radiation resistance • Outstanding dependability

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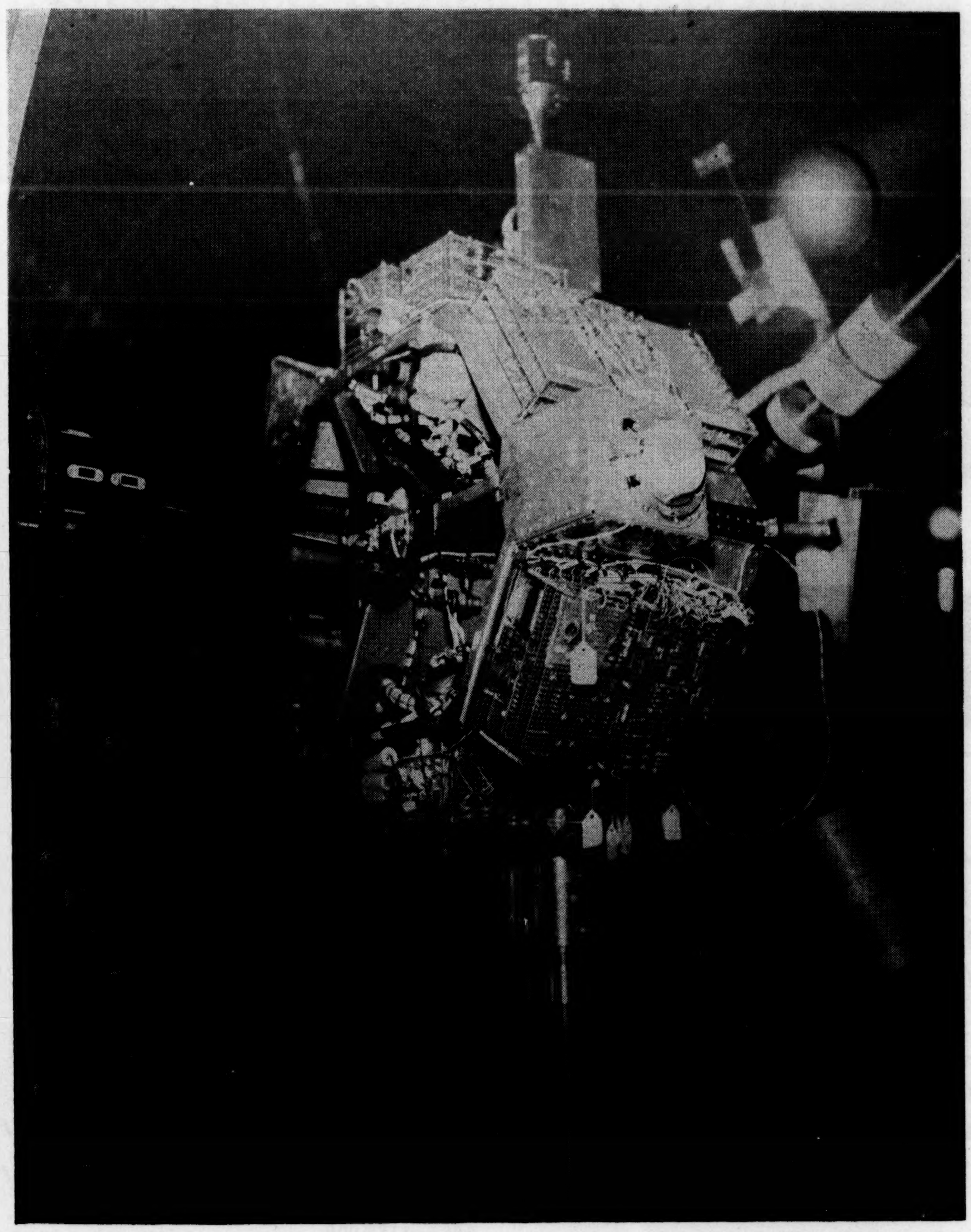


PREPROTOTYPE of the Nimbus control system is now being tested at GE's Philadelphia plant. All subsystems are presently breadboard configurations, but in operational satellites will be translated to 125 epoxy-encapsulated modules, forming wall panels within the basic structure. Note one of two infrared scanners mounted on corner of hexagonal-shaped unit.

closed box with a very narrow slit on one side and solar cells on the opposite inside wall, the sensor is so located on the control unit that it admits sunlight only when the rays are at right angles to the satellite's local vertical. The resulting output voltage is telemetered back to ground stations and there compared with the output of the gyro. If drift is discovered, ground stations will command a bias to be introduced into the summing amplifier to maintain accuracy of the yaw system.

Electronic Subsystems

Electronic subsystems of the 104-lb. control system are contained in 125 epoxy-encapsulated modules, mounted directly upon the structural walls. Aside from the 35 computer modules which are grouped together to form one complete panel, the subsystems are divided among different walls for weight and heat dissipation balance. Temperature range is to be held between 25C and 50C by the opening and closing of shutters mounted on opposite sides of the system. Gas in a tube snaked around the modules expands as the temperature inside the control system increases and drives a piston-like cylinder connected to the shutters.

Six-Month Lifetime

The system's six-month estimated lifetime is based on the capacity of the compressed nitrogen supply. Rare metals are used throughout the structure, with such features as solid gold ball-bearings and rhenium sliprings.

Power consumption of control system is 75 watts. The 3 a.c. motors have 26 v. across the fixed winding and 0 to 26 v. on the control winding.

GE has already built a preprototype and is now testing it at its Philadelphia facility. Prototype model, to be identical with operational units, is expected to be delivered to Goddard before the end of this year.

Space Subsidiary Of Aerojet Is Formed

Washington—Space-General Corp. has been formed as a subsidiary of Aerojet-General Corp. to design and develop missile and space systems, with plans to employ 1,600 scientists and supporting personnel by next February.

The subsidiary combines Aerojet's Spacecraft Division and the recently acquired Space Electronics Corp. President is Dr. James C. Fletcher, who headed Space Electronics. Frank W. Lehan is executive vice president.

Aerojet will continue work in propulsion, infrared, architectural services, structural plastics and chemicals. Space-General will continue its predecessors' programs on the Able Star, Aerobee and Astrobee vehicle systems, instrumentation for the Ranger, the Digilock deep space telemetry system and terminal guidance for ballistic missiles.

Dr. Fletcher said the company intends to bid on the Saturn S-2 engine stage and is proposing search and rescue satellites and a lightweight Prospector spacecraft capable of sampling the lunar surface as a Centaur payload. The light Prospector, weighing about 300 lb., would be based on the Surveyor design.

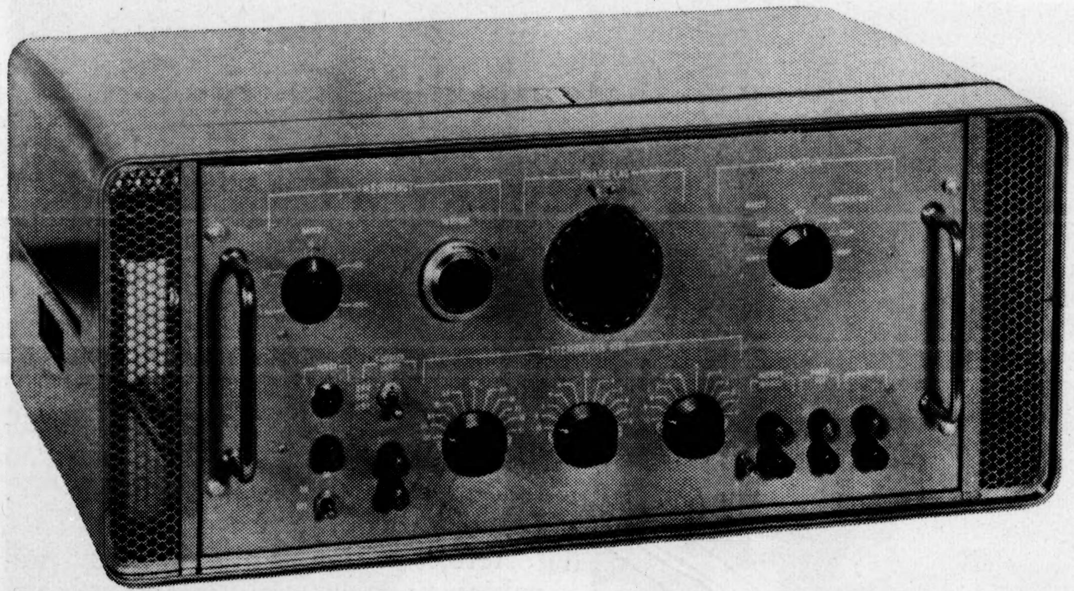
Aerojet President Dan A. Kimball said Space-General business volume at the end of the first full fiscal year is expected to be $20 million. The corporation, which goes into operation with about 700 employes, will be housed in a new plant to be built on a 73-acre site east of Los Angeles on the San Bernardino Freeway.

Mercury-Scout I To Check Out Tracking

Washington — Transmitter-receiver package containing 104 lb. of Mercury capsule communications equipment is being built by Aeronutronic Division of Ford Motor Co. for launch by a Blue Scout vehicle to check the Mercury tracking network.

The experiment, described last month by Aviation Week (AW June 12, p. 31), is scheduled for late summer. National Aeronautics and Space Administration said that the communications equipment will be placed in a 300-mi. circular orbit to provide real-time calibration, operator training and orbital flight test.

Test will be called Mercury-Scout I and the satellite will be useful as long as the batteries remain active. The communications system is powered by silver-zinc batteries and consists of HF and UHF transmitter-receivers, two ground command receivers, two telemetry transmitters and C- and S-band radar tracking beacons.



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Other important unit specifications are:

- carrier frequency range of 50 to 10,000 cps
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- signal attenuation of 0 to 99 db in 0.1 db steps
- phase measurement accuracy of 2°

Use of Vought Electronics Servo Analyzer has been demonstrated successfully with *Titan* and *Minuteman* missiles as well as in industrial laboratory applications. It is available in both bench and rack mounted models.

For more complete information about this versatile instrument, contact:

Chief of Product Sales
Chance Vought Electronics Division
P. O. Box 1500, Arlington, Texas

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USAF Contracts

Following is list of unclassified contracts for $25,000 and over as released by U. S. Air Force contracting offices:

HEADQUARTERS, AERONAUTICAL SYSTEMS DIVISION, (LMPMGC), Wright-Patterson AFB, Ohio.

Allison Division, General Motors Corp., Indianapolis, Ind., propeller systems for W2F-1 aircraft, supporting equipment and data, contract AF 33(600)42696, dated Mar. 3, 1961, $318,000.

The Goodyear Tire & Rubber Co., Akron, Ohio, wheel assemblies, FSN 1630-819-4622, Aerno 7380, 92 each, and brake assemblies, FSN 1630-819-4622, Aerno 7381, 54 each, (USAF Spares) change order No. 6 dated Mar. 29, 1961, to contract AF 33(600)41206, $25,796.

The Goodyear Tire & Rubber Co., Akron, Ohio, wheel assemblies (Main) 20.00-20, type III, contractor's P/N 9540765, Aerno 41-1178, 158 each; brake assemblies (20.00-20 wheel), type III, contractor's P/N 5940918, Aerno 41-1181, 322 each, spare parts and data, (installations for GV-1 Navy and USAF C-130 E/B aircraft) contract AF 33(600)-42891, dated Mar. 16, 1961, $216,584.

X-Ray Department, General Electric Co., Milwaukee, Wis., controls, exposure frequency for radarscope image, Aerno 74-0340, (components for the KS-32A camera system), USAF spares for B-52 aircraft, supplemental agreement No. 5, dated Mar. 2, 1961, to contract AF 33(600)42108, 2 each.

Kollsman Instrument Corp., Elmhurst, N. Y., components of MD-1 automatic astro compass, (applicable to B-52 aircraft), $5,611,131.

Stewart-Warner Electronics Corp., Stewart-Warner Corp., Chicago, Ill., components of radar altimeter SCR-718F, spare parts and data, (installations and spares for U. S. Navy, Coast Guard and Air Force) letter contract AF 33(600)42592, dated Feb. 8, 1961, $85,770.

Federal Systems Division, International Business Machines Corp., Rockville, Md., technical data (technical orders) for AN/ASB-9A, ground support equipment, letter contract AF 33(600)42779, dated Feb. 9, 1961, $188,000.

Allison Division, General Motors Corp., Indianapolis, Ind., product improvement engineering services for the T56 type engine, CY 1961, supplemental agreement No. 1, dated Dec. 27, 1960, to contract AF 33(600)40683, $6,000,000.

The Emerson Electric Manufacturing Co., St. Louis, Mo., facilities for B-52 and B-58 fire control system and F-101 subassemblies, contract AF 33(600)42678, dated Feb. 1, 1961, $29,375.

Miller-Holzwarth, Inc., Salem, Ohio, photographic enlargers, type EN-46, and data, contract AF 33(600)42873, dated Mar. 8, 1961, 4 each, $36,995.

Industrial Products Division, Boeing Co., Seattle, Washington, T-50-BO-4 engines, special support equipment and spare parts, metal engine shipping containers and data, letter contract AF 33(600)42855, dated Mar. 17, 1961, $290,000.

Small Aircraft Engine Department, General Electric Co., West Lynn, Mass., T-58-GE-8 gearbox assemblies, iaw/contractor's main reduction gear assembly spec. Nr. E-1051, dated Sept. 1, 1960, (for support of T58-GE-8 engine/HU2K-1 Navy aircraft), supplemental agreement No. 4, dated Mar. 1, 1961, to contract AF 33(600)-42313, 75 each, $672,599.

Snedaker, Budd, Monroe & Associates, Salt Lake City, Utah, title I, architectural engineering services, contract AF 33(600)-42856, dated Mar. 23, 1961, $77,835.

Allison Division, General Motors Corp., Indianapolis, Ind., T56-A-7 engines and data, (for C-130E aircraft) supplemental agreement No. 15, dated Mar. 16, 1961, to contract AF 33(600)41738, 76 each, $6,764,000.

Aerospace Industry Executives List Salaries, Stock With SEC

Washington—Following is a list of aerospace industry directors and officers with 1960 salaries above $30,000 and their stockholdings, as reported to the Securities and Exchange Commission:

Ryan Aeronautical Co.—T. C. Ryan, president and director, $72,500 salary, 109,007 shares of common stock; **R. C. Jackson**, executive vice president and director, $62,500 salary; **G. C. Woodard**, vice president, $32,500 salary; **C. A. Stillwagen,** vice president, treasurer and controller, $45,000 salary; **E. G. Uhl,** vice president, $45,000 salary; **C. A. Smith,** director, 3,600 shares of common stock; **A. J. Hair,** director, 241 shares of common stock.

Thompson Ramo Wooldridge, Inc.—J. D. Wright, chairman of the board, chief executive officer and director, $162,500 salary, 14,388 shares of common stock; **D. E. Wooldridge**, president and director, $100,167 salary, 43,120 shares of common stock, 300 shares held jointly with wife; **S. Ramo,** executive vice president and director, $100,417 salary, 46,680 shares of common stock, 1,090 shares held jointly with wife; **H. A. Shepard**, vice president and director, $97,500 salary, 4,400 shares of common stock; **B. W. Chidlaw**, vice president, and director, $76,625 salary, 600 shares of common stock; **A. T. Colwell,** vice president (retired Aug. 1, 1960) consultant and director, $47,465 salary, 12,000 shares of common stock; **J. H. Coolidge,** vice president and director, $83,250 salary, 13,500 shares of common stock; **F. C. Crawford**, consultant and director, $67,750 salary, 36,749 shares of common stock; **H. L. George**, vice president (retired Feb. 29, 1960), consultant and director, $31,449 salary, 27,735 shares of common stock; **R. P. Johnson,** vice president and director, $62,923 salary, 13,030 shares of common stock, 50 shares held jointly with wife, $400 4⅞% subordinated debentures held jointly with wife; **J. H. Doolittle**, director, 13,332 shares of common stock in Space Technology Laboratories (a subsidiary).

United Aircraft Corp.—W. P. Gwinn, president and director, $143,180 salary, 3,133 shares of common stock; **H. M. Horner**, chairman and director, $176,799 salary, 9,080 shares of common stock; **E. Martin**, vice president-research and development and director, $101,120 salary, 1,000 shares of common stock; **W. A. Parkins**, vice president-engineering and director (retired Sept. 30, 1960), $61,990 salary; **W. R. Robbins**, vice president, controller and director, $105,060 salary, 5,000 shares of common stock; **H. S. Beers**, director, 200 shares of common stock; **J. D. DeWitt**, director, 220 shares of common stock; **O. Enders**, director, 1,000 shares of common stock; **P. M. Fraser,** director, 500 shares of common stock; **L. S. Hobbs**, director (retired), 400 shares of common stock; **G. S. Moore,** director, 100 shares of common stock.

Westinghouse Electric Corp.—M. W. Cresap, Jr., president and director, $150,850 salary and 2,194 shares of common stock incentive compensation, 8,785 shares of common stock; **G. A. Price,** chairman of the board, $106,450 salary, 11,050 shares of common stock; **J. K. Hodnette**, executive vice president and director, $111,316 salary, and 1,536 shares of common stock incentive compensation, 13,376 shares of common stock; **E. V. Huggins**, vice president, chairman of the executive committee and director, $107,503 salary and 1,360 shares of common stock incentive compensation, 8,252 shares of common stock; **H. S. Kaltenborn**. vice president, assistant to the president and director, $80,379 salary and 987 shares of common stock incentive compensation, 200 shares of common stock **D. Anderson,** director, 1,000 shares of common stock; **K. R. Bendetsen,** director (from Sept. 1960); **R. H. Taylor,** director, 1,000 shares of common stock; **E. O. Boshell,** director and consultant, 800 shares of common stock; **H. B. Higgins,** director, 800 shares of common stock; **A. W. Jones,** director (from July, 1960), 500 shares of common stock; **W. A. Patterson,** director, 200 shares of common stock; **F. R. Denton,** director, 2,000 shares of common stock; **T. J. Hargrave**, director, 200 shares of common stock; **J. J. McCloy,** director, 200 shares of common stock; **D. C. Swatland**, director (since February, 1960), 200 shares of common stock; **E. Hopkinson, Jr.,** director, 400 shares of common stock; **J. W. Reavis**, director, 400 shares of common stock; **J. M. Schiff**, director, 25,000 shares of common stock. Stocks are listed as of Jan. 16, 1961.

Piper Aircraft Corp.—W. T. Piper, chairman of the board and president, $45,564 salary, 111,121 shares of common stock and 154,350 shares held in a trust; **N. J. Greene**, director, 2,000 shares of common stock, 2,000 shares held as "attorney in fact" with no beneficial interest therein; **R. K. Griffin,** director, 606 shares of common stock; **E. N. Hunting**, director, 502 shares including shares held jointly with wife; **W. C. Jamouneau,** director, secretary and chief engineer, 200 shares of common stock; **H. Piper**, director and vice president-research and development, 24,449 shares of common stock including shares held jointly with wife and shares held in a trust; **T. F. Piper,** vice president and director, 22,165 shares of common stock including shares held jointly with wife and shares held in a trust; **W. T. Piper, Jr.**, executive vice president and director, 22,764 shares of common stock including shares held in a trust; **C. W. Pool**, treasurer and director, 200 shares of common stock including shares held jointly with wife. Salaries are listed for the fiscal year ending Sept. 30, 1960 and stocks are listed as of Nov. 25, 1960.

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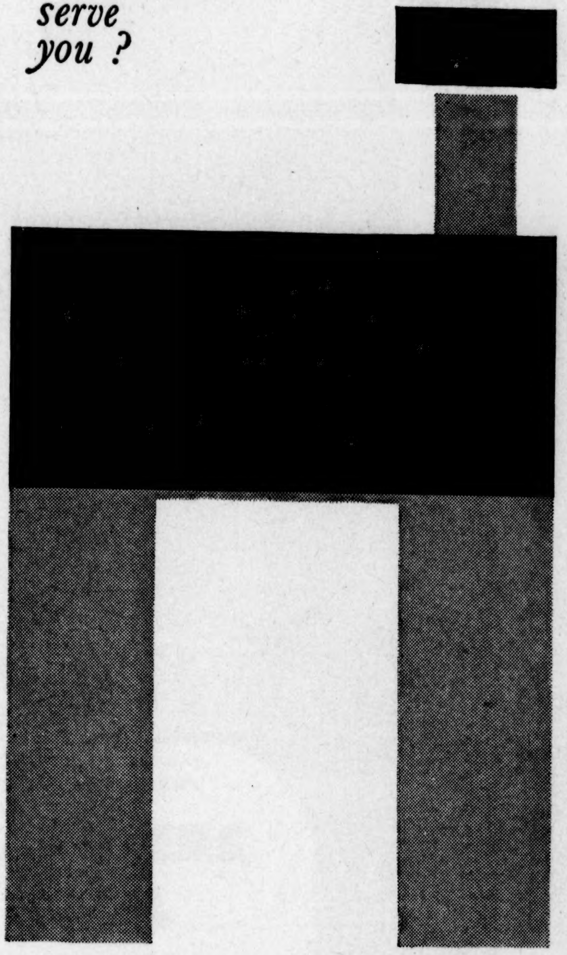

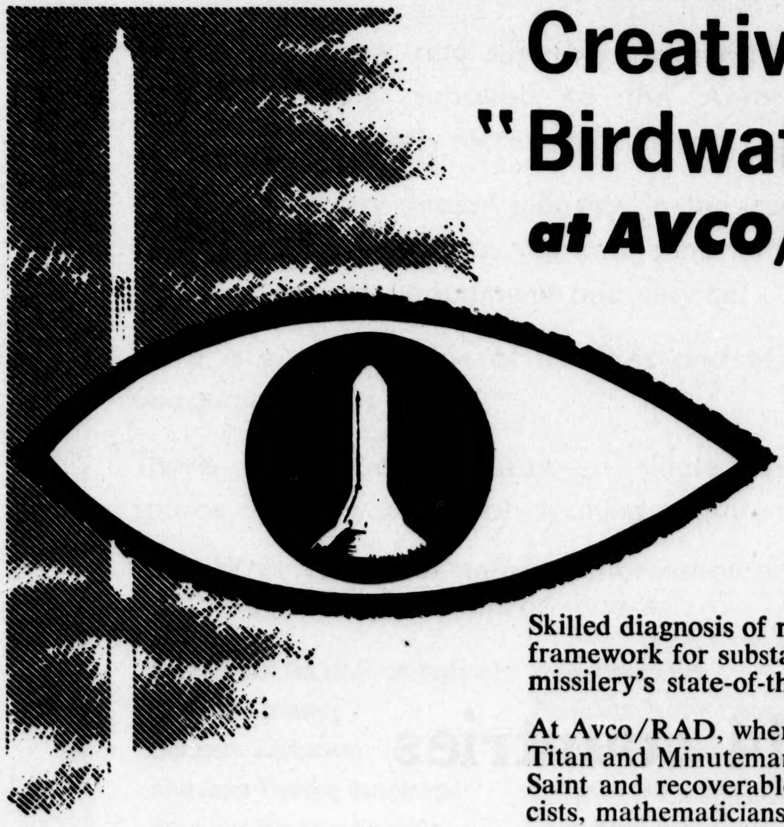

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New Offerings

Varian Associates, Palo Alto, Calif.; the company and its subsidiaries are engaged in the design, manufacture and sale of microwave tubes, electronic instruments, vacuum equipment and electronic systems and components for military, commercial and industrial use. Offering is 347,883 shares of capital stock, for subscription by shareholders at the rate of one new share for each 10 shares held; record date, subscription price and underwriting terms to be supplied by amendment. Of the proceeds, the company proposes to utilize approximately $3,870,000 for construction of two new buildings at its principal plant at Palo Alto, and for a new plant in Lexington, Ky.; $2,100,000 will be expended during the balance of 1961 and $4,500,000 during 1962 for additional equipment required for expansion of the company's productive capacity; $1,500,000 will be allocated for acquisition and development of an additional plant site; an unspecified amount of bank borrowings will be retired, and the balance added to working capital.

Advanced Scientific Instruments, Inc., Minneapolis, Minn.; organized under Minnesota law in March, 1961, the company proposes to engage in the business of developing, manufacturing, selling and leasing electronic, electro-mechanical and electro-optical equipment for use in the general categories of scientific calculation, automation and process control, data handling and processing, data recording, data communication, data conversion and guidance and navigation. Offering is 875,000 shares of common stock, for public sale at $1.15 per share. Of the proceeds (plus $112,000 proceeds from the sale of 112,000 common shares to the promoters), $100,000 will be used for equipment, installation costs and leasehold improvements, and 40% of the balance for developmental work during the first year of operations, and 60% for general working capital, including material, direct labor and overhead.

Anelex Corp., Boston, Mass., engaged in the design, development and manufacture of high-speed printers and high-speed paper tape readers for use in association with computers and electronic data processing equipment or systems; it is also engaged in research, development and manufacture of other electronic and electro-mechanical systems and equipment. A subsidiary is engaged in producing technical literature and manuals for industry and government agencies. Offering is 17,204 outstanding shares of common stock,

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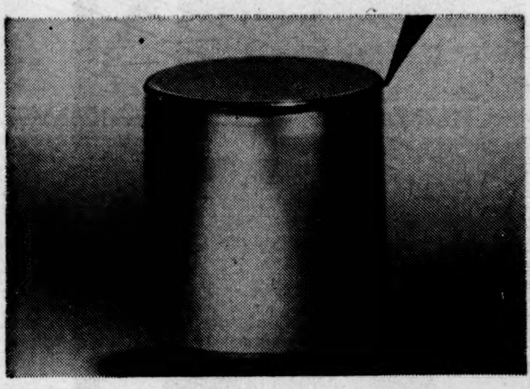
(Advertisement)

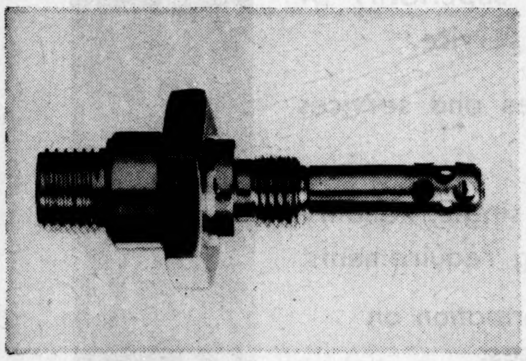
Airborne DC Amplifier



Small, solid state, direct-coupled DC amplifier weighs only six ounces. Less than five cubic inches in volume, this rugged, hermetically sealed instrument is available with solder, plug-in, coax or combination header arrangements and a variety of mountings. DC gain is 200 to 1000 ±0.75%. Input capability is 5 millivolts differential at maximum gain; output capability is ±5 volts into not less than 20K (single-ended).

Microdot Inc., 220 Pasadena Avenue, South Pasadena, California.

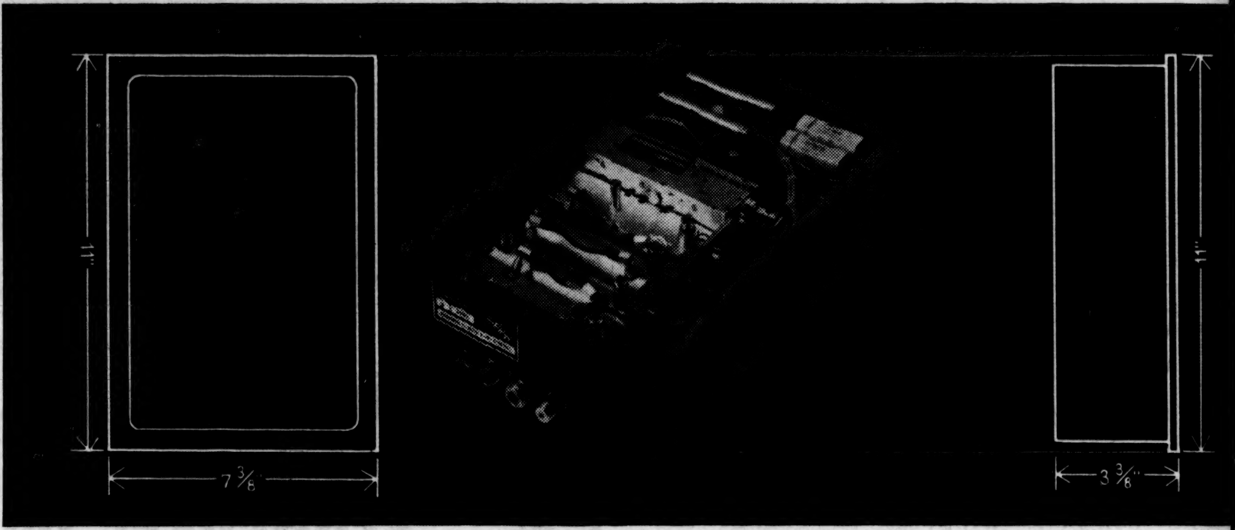
Temperature Transducer



Small probe-type device for high and low temperature applications where high pressures and severe flow conditions are imposed. Precise liquid or gaseous measurements to 800°F. Tiny sensing element of deposited platinum film allows high base resistance, extreme linearity, wide range capability, and fast response. Approved for ICBM environments.

Microdot Inc., 220 Pasadena Avenue, South Pasadena, California.

VHF-UHF TRANSMITTERS



Proved in history's most demanding environmental laboratory — outer space — the custom designed unit shown above is typical of the development skill and production capability available from Microdot. The unit shown in miniaturized, pressurized, and features a solid state power supply that cannot be damaged by input/output overloads. Units are available in a complete range of modulation — CW, FM, Phase, and Pulse, with frequency coverage 100 to 5000 mc/s and output from 100 mw to 10 watts.

Telemetry Capabilities at Microdot have been dramatically expanded with the recent acquisition of Spectralab Instrument Company. The highly regarded development skill, production capability, and working experience of Spectralab in the field of VHF and UHF cavities and related instrumentation is available from Microdot's Instrumentation Division. This equipment, outstanding in its attention to miniaturization and ruggedness, is a vital part of such important projects as Pioneer V, Jupiter, Atlas, Pershing, Redstone and Echo I.

UHF Telemetry Transmitters, Models 2406 and 2409, use a unique, automatically stabilized circuit, with the output frequency referenced directly to a quartz crystal. This approach allows a greatly reduced size compared to the multiplier chain conventionally required to achieve crystal stability, as well as increased reliability due to a fewer number of parts.

The transmitters have their own solid state power supply designed to provide a high ratio of rf output power to total power input. The frequency modulation circuitry is sufficiently linear to introduce completely negligible distortion to the modulation signal. For further information, Call Microdot or write for catalog sheet TT-1.

SPECIFICATIONS

Frequency Range:	
Model 2406	2200-2300 mc/s
Model 2409	1435-1535 mc/s
Frequency Stability:	±0.001%
Power Output:	10 watts
Power Output Stability:	1 db
Modulation:	PCM/FM, PAM/FM, FM/FM
Input Voltage:	28 vdc
Temperature Range:	−40°C to +70°C
Vibration:	10 g, 5-2000 cps
Size:	3⅜" x 7⅜" x 11"
Weight:	17 pounds

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MUrray 2-3351 SYcamore 9-9171

for public sale from time to time by the holders thereof in the over-the-counter market at prices related to the current market prices at the time of sale. Offering also includes: 10,000 common shares, owned by one of the selling stockholders, which are subject to purchase by three persons to whom options have been granted to purchase at $7.50 per share; 54,695 common shares, previously registered with the SEC and which underlie warrants which were attached to an issue of debentures previously sold, which warrants are exercisable after January, 1961, at from $16 to $17.50 per share. Proceeds from the exercise of the warrants will be added to the company's working capital.

Hathaway Instruments, Inc., Denver, Colo., engaged in the design, manufacture and sale of electro-power recording instruments for the electric utilities industry, electronic measuring and testing instruments for commercial and military use, and airborne recorders used in certain phases of missile training. Through wholly owned subsidiaries, the company is also engaged in the design, manufacture and sale of resistors, trimmer potentiometers, printed circuits, airborne antenna, lightning arrestors, and electro-mechanical assemblies; industrial electric motors and reduction gear assemblies; induction and dielectric heating devices; pneumatic and hydraulic equipment used in the control surfaces of jet aircraft and missiles. Offering is 351,280 shares of common stock; of this stock, an unspecified amount (up to 90,000 shares) is to be offered for public sale by the present holders thereof.

Science Capital Corp., Philadelphia, Pa., organized under Pennsylvania law in March, 1961, the company is a small business investment company (was expected to be licensed in May 1961 under the Small Business Investment Act of 1940) and registered as a closed-end non-diversified management investment company under the Investment Company Act of 1940. Business will consist of furnishing capital, through the purchase of equity and debt securities, to selected small business concerns engaged principally in the field of applied science and modern technology; making long-term loans to such concerns; providing advisory and management counselling services and rendering specialized financial, administrative and technical assistance to such concerns in which the company has or will invest. Offering is 450,000 shares of common stock for public sale at $8 per share; offering to be made on an all or none basis. Proceeds will be used to provide investment capital and management services.

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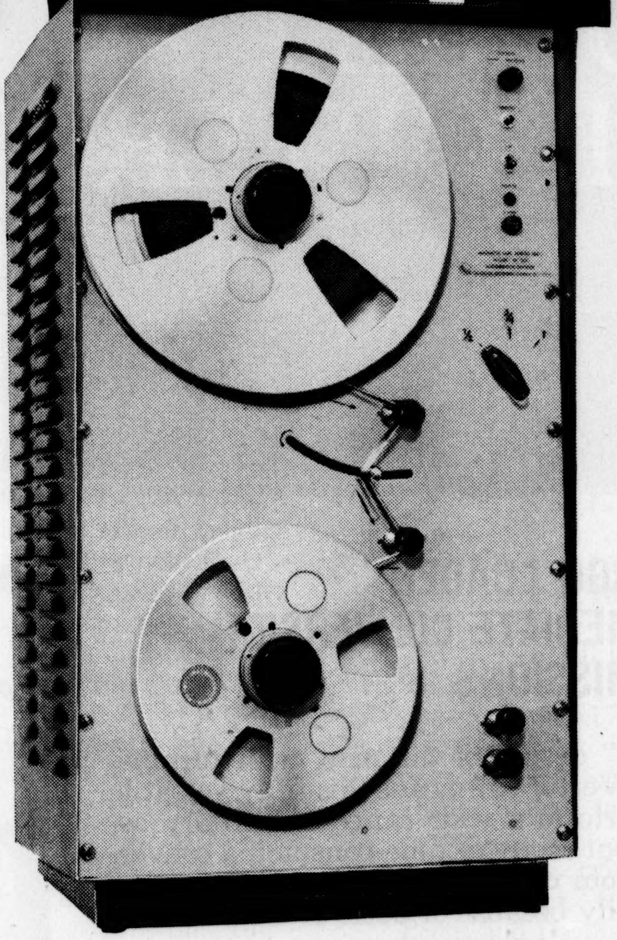

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TOP PHOTO: FULL SCALE DEVELOPMENT MOCKUP

SAFETY

CAB Accident Investigation Report—Part I:

Nacelle Oscillation Led to Electra Crash

At 1525 c. s. t., on March 17, 1960, a Lockheed Electra, model L-188C, N 121US, owned and operated by Northwest Airlines, Inc., crashed approximately six miles from Cannelton, Indiana, after failure of the right wing. All 63 persons on board were killed.

Flight 710 departed Chicago, Illinois, at 1438 c. s. t., on an intended nonstop flight to Miami, Florida. The flight was to cruise at 18,000 feet. All reporting points were made on time and the flight was progressing according to plan; no messages were received which indicated that the crew of Flight 710 was experiencing any difficulties.

It is the conclusion of the Board that flutter was induced by oscillations of the outboard nacelles and that this reached a magnitude sufficient to fail the right wing. Reduced stiffness of the structure and the entry of the aircraft into an area of severe clear air turbulence were contributing factors.

INVESTIGATION

Northwest Airlines Flight 710 of March 17, 1960, a Lockheed Electra aircraft, N 121 US, was scheduled between Minneapolis, Minnesota, and Miami, Florida, with an intermediate stop at Midway Airport, Chicago, Illinois. The crew consisted of Captain Edgar E. LaParle, First Officer Joseph C. Mills, Flight Engineer Arnold W. Kowal, Stewardesses Constance M. Nutter and Barbara A. Schreiber, and Flight Attendant Mitchell D. Foster.

Prior to departure the crew was briefed by the company meteorologist on the present and expected weather conditions along the route. This briefing consisted of a general discussion of the synoptic situation, a review of the en route and terminal forecasts, together with all sequence and pilot reports. The meteorologist said that thunderstorms which were located in Florida were discussed as was the intensity of the jet stream over the southeastern states, the latter because it appeared to be growing in intensity. No mention was made, however, of any clear air turbulence being present along the route.

A flight plan was prepared which indicated a flight in accordance with instrument flight rules (IFR), via Victor Airways 2, 97, and 6, to Midway, a cruising altitude of 15,000 feet, a true airspeed of 340 knots, and an estimated time en route of 53 minutes.

The flight departed Minneapolis at 1251[1] and arrived at Midway at 1355; the trip to Chicago was routine. It should be noted that some of the passengers said the landing at Chicago was very hard; others said that it was a normal landing in every respect.

During the short time the aircraft was on the ground at Chicago, approximately 30 minutes, it was refueled and prepared for continuation of the flight to Miami. While this was being done Captain LaParle went to the company operations office where he reviewed the latest weather information pertaining to the flight. There is no company meteorologist stationed in Chicago. As a matter of company policy this same weather information was later attached to the flight's clearance papers and given the crew prior to departure. These papers are kept in the cockpit throughout the flight.

The flight plan, prepared by the crew and filed with company operations, indicated a flight from Midway Airport via Victor Airway 53 to Peotone, Illinois, Victor 171 to Scotland, Indiana, Victor 243 to Chattanooga, Tennessee, Victor 51W to Atlanta, Georgia, Victor 97 to Albany, Georgia, Victor 159W to Cross City, Florida, Victor 7 to Fort Myers, Florida, and Victor 35 to Miami, Florida; a cruising altitude of 18,000 feet, a true airspeed of 337 knots, and an estimated time en route of 3 hours and 37 minutes. The clearance given the flight by Air Route Traffic Control (ARTC) was, "NW 710 cleared to the Miami Airport, Peotone, Victor 171 to Scotland, flight planned route, maintain 18,000."

The flight departed Chicago at 1438 with 57 passengers, including one infant. The gross weight of the aircraft at the time of takeoff was 107,661 pounds; this was within the maximum allowable gross takeoff weight limitation of 110,590 pounds, which limitation was imposed in order to comply with the maximum allowable gross landing weight at Miami. According to company records the center of gravity was within prescribed limits.

At 1445, the flight reported to the Indianapolis, Indiana, ARTC Center over Milford, Illinois, at 18,000 feet and estimating Scotland, Indiana, at 1512. At 1513, Flight 710 reported over Scotland maintaining 18,000 feet and estimating Bowling Green, Kentucky, at 1535. At this time the flight was advised by ARTC to contact the Memphis, Tennessee, ARTC Center on 124.6 mcs., at 1530. The 1513 contact was the last known radio communication with the flight.

At approximately 1640, reports were received by Northwest Airlines at Minneapolis that Flight 710 had crashed near Cannelton, Indiana. The time of the crash was established as approximately 1525.

A radar operator at the Indianapolis Air Surveillance Station reported that he monitored the flight by radar to within seven miles of Scotland, Indiana, and that the flight appeared to be normal.

Surface stations nearest to the route reported a broken to overcast cloud deck from the Chicago area to Terre Haute, Indiana, with an average base altitude of 1,500 feet above the ground. Above this cloud deck was a second cloud layer which was broken to overcast with its base at approximately 4,000 feet. This upper layer extended from Chicago at the scene of the accident and its tops were reported by pilots as being 7,000 to 7,500 feet near Chicago and becoming 5,000 to 6,000 feet between Evansville, Indiana, and Louisville, Kentucky. Generally clear conditions prevailed above these cloud formations with inflight visibility unrestricted in central United States.

Considering upper wind reports available from ground based observations as well as pilot reports, the following data has been extracted relative to the magnitude of horizontal and vertical shears as well as wind shift across the troughline (along the Illinois-Indiana border).

1800 c. s. t. Data
Horizontal Shear at 16,000 feet=39 kts./150 N. M.
at 18,000 feet=52 kts./150 N. M.
Vertical Shear
Nashville, 16,000-18,000 feet=10 kts./1,000 feet.
Dayton, 16,000-18,000 feet=2.5 kts./1,000 feet.
Wind shift across trough
At 18,000 feet, 50 degrees between Peoria and Dayton
60 degrees between Peoria and Nashville
At 16,000 feet, 40 degrees between Peoria and Dayton
30 degrees between Peoria and Nashville

0600 c. s. t. Data
Horizontal Shear at 16,000 feet=48 kts./150 N. M.
at 17,000 feet=80 kts./150 N. M.
Vertical Shear
Nashville, 16,000-17,000 feet=26 kts./1,000 feet
Dayton, 16,000-18,000 feet=0
18,000-20,000 feet=5.5 kts./1,000 feet
Wind shift across trough
At 18,000 feet, 60 degrees between Peoria and Dayton
At 16,000 feet, 50 degrees between Peoria and Dayton
40 degrees between Peoria and Nashville

PILOT REPORTS

- **1310 c. s. t.,** 50 miles south Dayton, moderate to severe clear air turbulence 20,000 feet—500 feet thick—F-101.
- **1400 c. s. t.,** Cincinnati, moderate to heavy turbulence 20,000 to 25,000 feet, T-33.
- **1430 c. s. t.,** New Hope, Kentucky, choppy at 21,000, 10-15 degrees centigrade temperature drop at edge of jet stream. Descended and showed severe airspeed fluctuation and turbulence—Electra.
- **1515 c. s. t.,** Columbus, Ohio, to York, Kentucky, moderate to severe turbulence 11,000-17,000 ft.—aircraft type unknown
- **1500 c. s. t.,** Louisville to Cincinnati, moderate clear air turbulence 17,000 to 25,500 feet—B-57.
- **1530 c. s. t.,** 50 miles north Louisville, de-

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[1] All times herein are Central Standard based on the 24-hour clock.

LITTON ALL-INERTIAL AUTOMATIC NAVIGATOR INSTALLED IN AN OPERATIONAL FIGHTER

NEW PROOF OF LITTON'S CONTINUING CONTRIBUTIONS TO THE DEVELOPMENT OF INERTIAL NAVIGATION IS FURNISHED BY THE LN-3-2B AUTOMATIC NAVIGATOR THAT IS NOW BEING INSTALLED IN CANADA'S CF-104 FIGHTER.

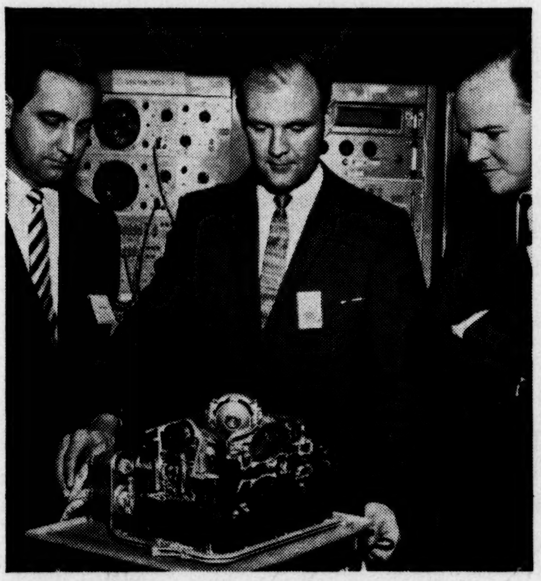
Three-hundred-and-sixty-degree freedom of aircraft maneuver on every axis is made possible by four-gimbal isolation of the Litton stable platform that keeps the system's accelerometers aligned in inertial space. Voltage signals from the accelerometers are transmitted to a computer where they are integrated to compute vehicle position components.

In addition, an adapter unit provides 27 outputs of pitch, roll and heading angles and ground speed to other equipment in the aircraft such as bombing computer and autopilot.

In flight, tight servo loops hold all sensitive elements of the stable platform at null regardless of acceleration. Any relative motion between the gyro case, which is fixed to the platform, and the floated gyro rotor, which is fixed in space, is sensed and corrected to keep the platform including accelerometers oriented to vertical and north. Any acceleration along an axis produces an accelerometer torquer current which is proportional to the applied acceleration. This torquer current holds the accelerometer at null, and the same signal is transmitted to the navigation computer.

Another indication of the scope and caliber of Litton inertial engineering is the new combined doppler and inertial navigation system being produced by Litton Systems for the Lockheed P3V-1 anti-submarine patrol aircraft. The inertial system continuously measures accelerations along the two horizontal axes and computes velocity components and aircraft position in latitude and longitude. Velocity information from the AN/APN-122 doppler radar is used in the inertial navigation system to optimize system performance.

A half dozen other Litton inertial navigation systems have been successfully developed to the operational phase. Still others are now in earlier phases of development.

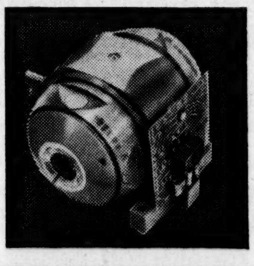


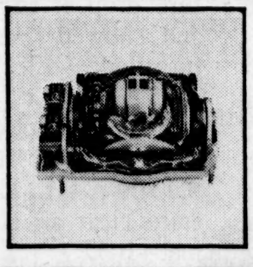
EXAMINING LN-3 STABLE PLATFORM UNDER TEST AT LITTON'S WOODLAND HILLS, CALIF. FACILITY ARE L-R: VIC SYMONDS, LITTON-CANADA; P. LUTH, LITTON-CALIF.; D. BELYEA, DDP.

These programs are being carried forward by engineers specializing in inertial navigation and related techniques. By engineers with their own long-range plans, and the ability to make important contributions to inertial engineering. By engineers who prefer engineering to paper work. By engineers willing and able to see a job through from concept to product.

Are you specially qualified in inertial equipment, computers, data processing systems, tactical data systems, displays, advanced communication techniques? Write today to Donald Krause, Research & Engineering Staff, Litton Systems, Inc., 336 No. Foothill Road, Beverly Hills, California.

Qualified applicants will be considered regardless of race, creed, color or national origin.





LITTON SYSTEMS, INC.
Beverly Hills, California

DIVISION OF LITTON INDUSTRIES

creased speed and descended from between 20,000 and 25,000 to 15,000 feet because of heavy to severe clear air turbulence—B-57.

- **1640 c. s. t.**, Louisville to Nabb, Indiana, severe clear air turbulence 19,000 feet—DC-7.
- **1830 c. s. t.**, Cincinnati, moderate to severe clear air turbulence 11,000 to 17,000 feet—Constellation.

The synoptic situation as reported on the surface weather chart for the midafternoon of March 17, 1960, was as follows: A low pressure area was centered over the northern portion of the lower peninsula of Michigan. This low pressure area extended to high levels (above 30,000 feet). A marked troughline at all altitudes extended southward from this low along the Illinois-Indiana border. A ridge of high pressure extended from the southern plains northeastward across Arkansas, western Tennessee, central Kentucky, and into southern Ohio.

The written forecasts published by both Northwest Airlines and the United States Weather Bureau and available to the crew of Flight 710 at Minneapolis and Chicago reflected the wind field as shown by the observed data. It is important to note, however, that neither of these sources of weather information mentioned the possibility of clear air turbulence along the route.

WITNESSES

Approximately 75 groundwitnesses who were near the accident scene and a number of airmen who were flying in the area at the time were interviewed.

The laywitnesses were located within an area that included the most distant places from which the aircraft could be seen or the aerial explosion heard by a person having normal vision and hearing.

A composite description of what these witnesses saw and heard follows: The time was 1515. The weather was clear except for scattered cumulus clouds with bases at about 4,000 feet; visibility was good. The aircraft was flying in an approximate north to south direction, in level flight, and at a high altitude. Suddenly two puffs of white smoke were seen. Seconds later these were followed by a large cloud of dark smoke. Two loud explosions were then heard and a large object was seen to emerge from the smoke cloud and fall nearly vertically, trailing smoke and flame. Smaller objects were later seen to fall. The fuselage continued in level flight for a few seconds and then fell to the ground describing a large trajectory arc as it did so. It struck the ground with such terriffic force that debris was thrown nearly 250 feet into the air.

Six USAF aircraft were on a refueling mission in the area at an altitude of 31,000 to 32,000 feet. Three of these aircraft were KC-135s and three were B-52s. Airmen manning these aircraft said that they first saw the smoke trail of this accident at 1532. The cloud was the shape of a child's top, dark in color as if produced by burning some product with a petroleum base. The bottom of this smoke disappeared into scattered clouds. A horizontal stream of dark smoke which began a considerable distance north terminated at the smoke cloud.

The smoke cloud was first sighted when they were 26 nautical miles north-northwest of it. Their bearing of approximately 170 degrees nearly paralleled the course of Flight 710. They passed abeam of the smoke cloud at 1539, at which time they were about 12 nautical miles west of it.

During the seven-minute period, from first sighting the smoke of the abeam check, the smoke cloud and streamer retained its original form with little or no indication of dissipating or breaking up. The USAF airmen estimated the smoke cloud to be at an altitude of 25,000 feet.

WRECKAGE DISTRIBUTION

The major portion of the aircraft struck the ground in a nearly vertical attitude in a field where the ground sloped to the south. The soil at the point of impact was soft and contained no rocks. Small trees near the point of impact were not struck by the aircraft. Impact forces formed a crater which measured 30 feet across its top from east to west and 40 feet from north to south; it was 12 feet deep. Most of that portion of the aircraft which struck the ground forming this crater disintegrated and was buried within it. Only a few fragments of wreckage were visible in the bottom of the crater. A shallow depression 2 feet deep and 11 feet wide extended southward from the crater for a distance of 16 feet.

Fragments of the left wing were visible in this depression. Portions of the vertical tail were imbedded in the west rim of the crater with the crumpled upper end of the rudder protruding from the ground. Pieces of horizontal tail structure were imbedded in the north rim of the crater. A smoldering

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fire burned below the surface of the crater bottom for several days until extinguished during excavation. The impact explosion hurled small pieces of wreckage in all directions from the crater, the greatest distance being approximately 1,500 feet to the east and southeast. The heaviest concentration of wreckage scattered by the impact explosion was in the southeast quadrant within a radius of 100 feet from the crater. The southwest quadrant contained a moderate to heavy concentration of pieces, and only a light scattering of pieces was found in the northwest and northeast quadrants. The geographical location of the crater was 37°54″38′N. Lat. and 86°38″W. Long., or approximately six miles due east of Cannelton.

The south end of the crater contained the No. 2 engine and propeller, parts of the left main gear, and wing structure, including flap pieces, aileron, and trim tab sections. The north end of the crater contained the fuselage structure, cockpit control system, electrical panel bits, various system components, nose gear pieces, elevator torque tubes and rudder post, bits of tail structure, servos, etc. Upon removal of the wreckage from the crater it was apparent that the fuselage with its tail, most of the left wing, and the No. 2 powerplant had contacted the ground in an almost vertical nose-down position.

All structure removed from the crater was found to be severely fragmented from the ground impact.

At the completion of the excavation the main crater measured 53 feet across the top from north to south, excluding the extension into the area where the left wing pieces and No. 2 engine and propeller were removed. The measurement across the top east to west was 44 feet. The excavation of the crater was continued to a depth of 31 feet until there was no further evidence of any structure remaining in either the sidewalls or bottom.

A preliminary survey of the accident area by helicopter disclosed that, in addition to severely fragmented wreckage at the crater, the main portion of the right wing, the outboard powerplants, and many small pieces of wreckage were widely scattered in a general direction north and northeast from the crater.

Approximately 350 soldiers from nearby Fort Knox were used in a ground search of a 21-square mile area. The soldiers covered this area by walking in a line abreast. Investigating personnel followed the line of soldiers, marking, identifying, and plotting the location of each scattered piece of wreckage as it was found.

The parts which separated from the aircraft in flight consisted of the complete right wing with powerplants, the outer end of the left wing and aileron, the No. 1 QEC and nacelle, and the outboard portion of the left elevator.

The right wing was found on a bearing of 10°30″30′ at a distance of 11,291 feet from the crater. The Nos. 1 and 4 power sections and their respective propellers with reduction gears were found as four separate pieces all within a radius of less than 2,000 feet of the right wing. Nearly all of the scattered parts of the right and left wings and the outboard nacelles were distributed along a path approximately one mile wide and nearly seven miles long. The magnetic

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PROBLEMATICAL RECREATIONS 74

Smith and Jones, both 50% marksmen, decide to fight a duel in which they exchange alternate shots until one is hit. What are the odds in favor of the man who shoots first? *–Contributed*

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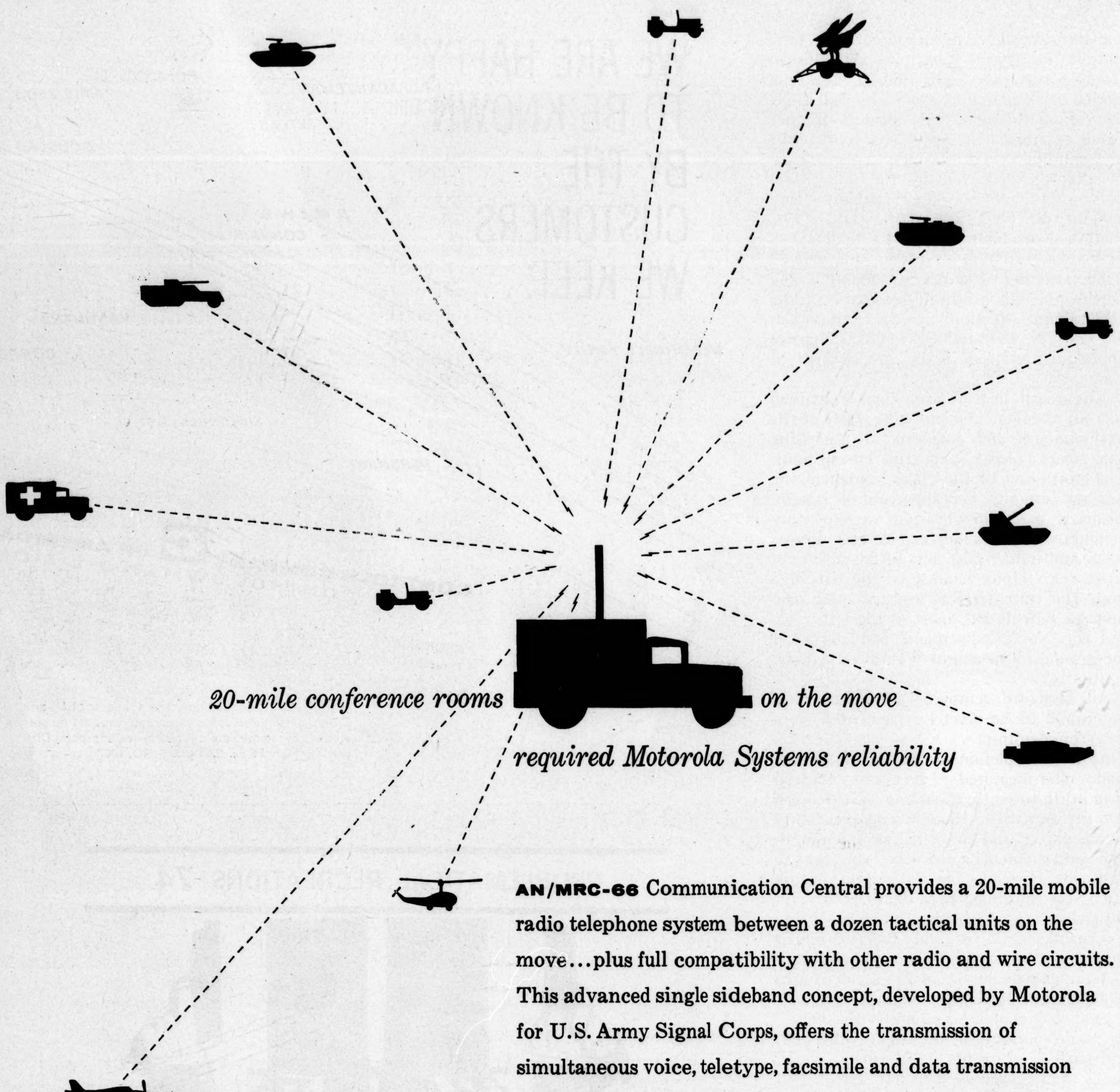
ANSWER TO LAST WEEK'S PROBLEM: As we have to exclude complex and improper fractions and recurring decimals, the simplest solution is this: 79 + 5 1/3 and 84 + 2/6. Both equal 84 1/3.

LITTON INDUSTRIES, INC.
Beverly Hills, California



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heading of this scatter path was approximately 70 degrees or at nearly right angles to the flightpath, with the heavier of the scattered pieces found at the west end and the least dense at the east end.

The outlying components of the aircraft, the powerplants, and propellers were transported by Army helicopter to an area near the crater. From that location all of the salvaged aircraft structure was transported in CAB sealed vans to the Lockheed Aircraft Corporation at Burbank, California, for further examination. The powerplants were similarly transported to the Allison factory at Indianapolis, Indiana.

AIRCRAFT STRUCTURES

Study of the wreckage and wreckage distribution at the scene of the accident disclosed that the outboard powerplants and engine support structures, the complete right wing, and the outer portions of the left wing and aileron separated from the rest of the airplane in flight during such a short time interval that the sequence of these separations was not apparent. In addition, the main wreckage, the outboard engine support structures, the outer end of the left wing, and the portion of the right wing between the fuselage and the inboard nacelles, were so severely disintegrated that detailed study was necessary to identify numerous pieces of wreckage and to determine the nature of the failures.

To facilitate the necessary detailed study of the wreckage, various "reconstructions" of different parts of the structure were made in a restricted area at the Lockheed factory. Primary interest centered on the outboard engine support structures and on the inboard portion of the right wing. As a result, these portions of the structure were mocked-up in three dimensions. Simpler "reconstructions" were used in connection with the rest of the wing, the horizontal tail, and the vertical tail. Flight control system parts and fuselage wreckage were examined without "reconstruction."

Numerous fractured pieces of wreckage were subjected to metallurgical examinations and analyses in the Lockheed laboratories. These examinations disclosed no evidence of fatigue cracking, nonconforming material, over-torquing of nuts, or missing attachments. They did yield evidence as to the direction of loads producing failures.

Examination of the fuselage, the vertical tail, the landing gear, and the flight control systems disclosed no indication of malfunction or failure prior to impact with the ground, other than control system failures resulting from the right wing separation in flight.

The only indication of malfunction or failure in the horizontal tail, prior to impact with the ground, was that the portion of the left elevator outboard of the hinge of station 147.8 disintegrated and separated from the airplane. As indicated by the wreckage distribution, this occurred appreciably subsequent to the wing and outboard powerplant separations and very shortly before the main wreckage struck the ground. The separated pieces of elevator skin bore numerous wrinkles and small tears in the wrinkled areas as a result of repeated deformations of high magnitude consistent with both upward and downward twisting and bending of the elevator. This damage is typical of flutter

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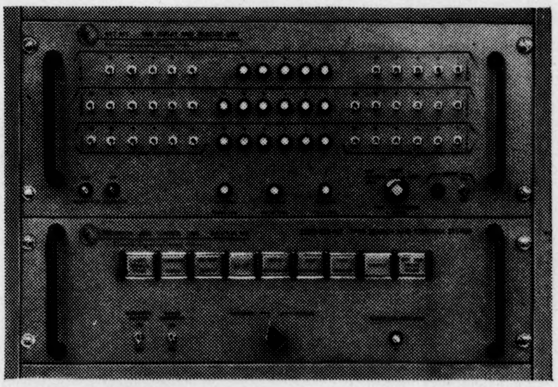
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That's searching 1200 feet of multi-channel tape in 90 seconds. This is the kind of performance that instrumentation and data reduction engineers are experiencing with EECO *time-code* referenced magnetic tape search-control systems. *Time-coded* for either binary or binary-coded decimal readout — Atlantic Missile Range, IRIG or NASA. EECO search-control systems automatically search, detect, and play back the type and quantity of data you designate in a matter of seconds to minutes. *Time-coded* EECO search-control systems end speed variation inaccuracies. Continuous display of time code to within 1 second of data location. Search-to-recording speed ratios to 64/1. No manual switching or plug changing to compensate for speed changes. Fully automatic with manual search options. Solid-state compactness. Broad compatibility. Low initial cost. Low maintenance cost. P.S. Found the needle yet?

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EECO 822	9,500	EECO 842	4,750	17-Bit, 24-hour, Binary Code as produced by TCG* EECO 802 (Eglin AFB and Atlantic Missile Range codes)
EECO 823	10,200	EECO 843	5,100	20-Bit, 24-hour, BCD code as produced by TCG* EECO 803
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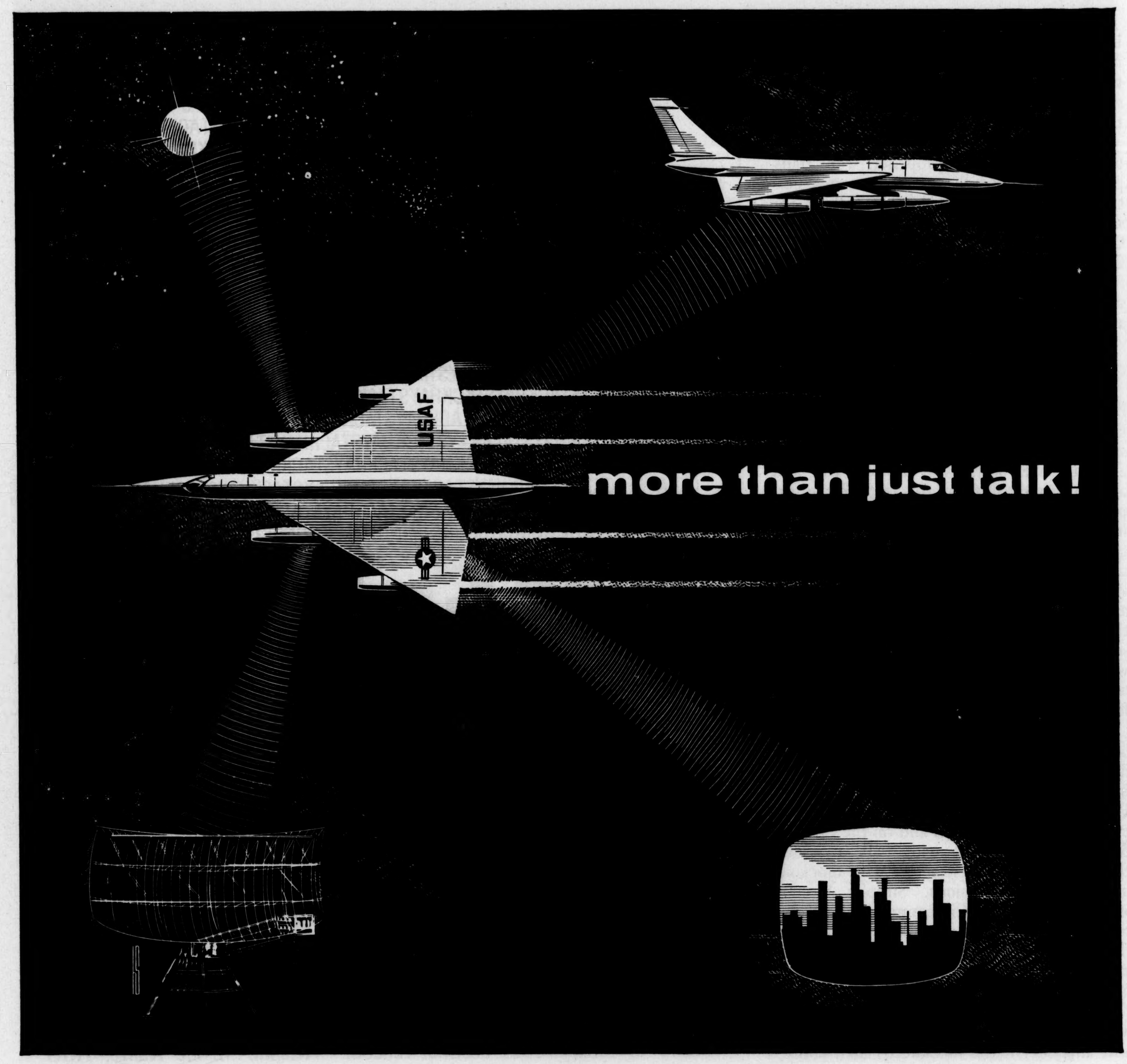

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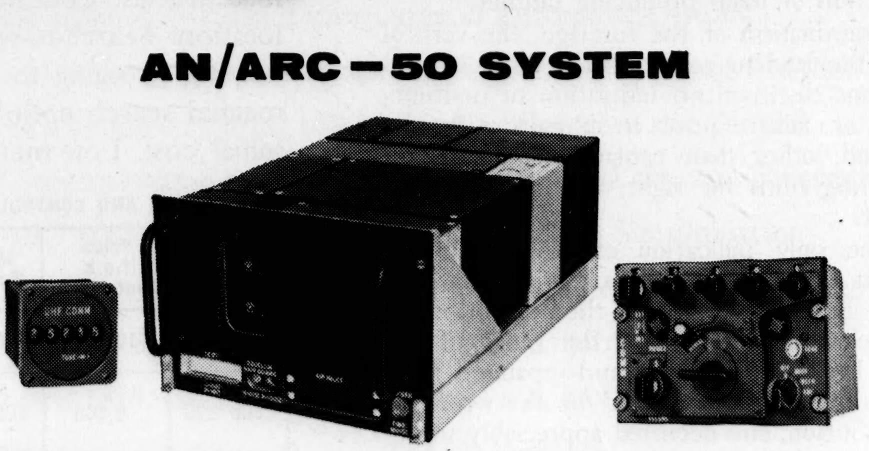

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in conventional sheet metal construction.

The left wing "reconstruction" disclosed that from an irregular fracture line, roughly centered at station 482, inboard to the fuselage the left wing structure, aileron, and flap remained attached to the fuselage until it struck the ground. The portions of the left wing and aileron outboard thereof fragmented and separated from the airplane in flight. Study of the fractures in the outer end of the wing box section disclosed that they resulted from excessive fluid pressures pushing the upper and lower covers and the front and rear spars away from the intermediate truss-type ribs. Similarly, outward-acting fluid pressure pushed the solid tip rib at wing station 584 off the ends of the spars. This rib is the outboard bulkhead of the outboard fuel tank, which extends inboard to wing station 221, with no intermediate bulkheads or baffles other than the truss-type ribs at 17 to 18 inch spacings. Failure and separation of the outer end of the left aileron resulted from rearward bending as a consequence of the wing box section disintegrating.

Similar but lesser damage was found at the outer end of the right wing box section. There a large segment of the upper cover was forced upward off the truss-type ribs and separated from the wing in flight. In addition, the solid end rib at station 584 and the outer end of the front spar web were bulged outward and partially separated from each other. The damage to the outer ends of both the right and left wing box sections is consistent only with excessive pressures generated by fuel in the partially filled outboard tanks ramming into the outer end as a result of high rotational accelerations associated with failure of the right wing at the root. Overpressurization of the outboard tanks during refueling would have caused prior distress much farther inboard.

DAMAGE STUDY

Study of the damage to the right wing between the fuselage and the inboard nacelle disclosed a fracture in the front spar at wing station 78 and one in the rear spar at wing station 101. These were the inboard ends of the spar sections which remained with the separated right wing. The upper and lower wing covers and ribs between the spars in this area were shattered and many pieces fell to the ground separately when the wing separation occurred. The hinged leading edge between the fuselage and the right inboard nacelle also fell to the ground separately in a number of pieces.

This hinged leading edge separated from the wing by the upper skin pulling off the rivet heads in a generally forward direction at the attachment to the terminal extrusion which connects to the upper cap of the front spar. After this failure the leading edge rotated downward to the limit of travel of the piano hinge which attaches to the lower cap of the front spar, and the rear lugs of the piano hinge fractured in bending. The end ribs of this hinged leading edge were damaged by interference with the ends of the adjoining fixed leading edge sections. Some of this damage was normal service wear from interference with the gap seal back-up angles. Superimposed on this were scratches and rib deformations from abnormally large up-and-down movement of the hinged segment relative to the fixed segments and from abnormally large up-and-down spanwise bending deflections.

Prior to separation of the inboard hinged leading edge from the wing, as indicated by an abrupt discontinuity in the direction of the leading edge upper skin pulling off the heads of the rivets in the seam paralleling the upper spar cap, a section of the right wing front spar upper cap flange buckled upward, separating from the vertical leg of the spar cap with outward progression of the crack between stations 78 and 89. At and adjacent to station 78 the upper part of the front spar web buckled and took an "S"-shaped deformation after the above-mentioned flange separation. At station 78 there was also a vertical fracture of the front spar web, which preceded a horizontal fracture extending outboard from station 78. The rear spar failed at station 101 in rearward bending. Tears of the spar cap flanges from the vertical legs of the spar caps progressed outward considerable distances from the spar fractures.

The upper and lower covers of the Electra wing consist of long 7178 and 7075 aluminum alloy extruded planks machined to form spanwise stiffeners integral with the skin. The low energy absorption and yielding of these materials prior to failure results in fractures singularly lacking in indications of the loads producing failure and of failure progression. However, the fact that irregularly saw-toothed diagonal fracture lines in the bottom cover of the right inboard wing extended from the front spar at station 83 to the aft edge of plank 4 at station 155, and from the aft edge of plank 5 at station 155 to the rear spar at station 95, indicates repeated reversals of loading during the breakup.

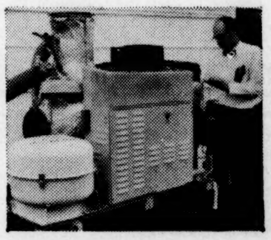
Laboratory examinations of the fractures also disclosed some indications of both tension and compression due to alternate upward and downward loading of the wing, combined with corresponding reversals of shear due to torsion. Slight spanwise bowing of two large separated pieces of the lower cover in this area is consistent with permanent set due to long column buckling at a time when the ribs at stations 83, 101, and 119 were providing little or no lateral restraint.

The fractures of the right wing upper cover between the fuselage and the inboard nacelle had some characteristics of local compression buckling of the upper surface between stations 83 and 101 and some characteristics of the wing hinging about a chordwise line through the upper surface between stations 83 and 101 after the structural integrity of the front spar and lower surface was destroyed. Directly aft of the front spar, at and adjacent to station 83, the upper cover fractures occurred in conjunction with the spar cap flange separating from the vertical leg and buckling upward.

Reconstruction and study of the right wing ribs at stations 83, 101, 119, 137, 143, and 155 disclosed no uniform pattern of failure in the diagonals, partly due to the lack of sufficient evidence to make a positive determination of the exact manner in which most of the diagonals failed. However, there were a few positive instances of failure consistent with nosedown torsional loading.

Several of the rib diagonal failures were quite similar in appearance to corresponding ones found in an American Airlines' Electra

Barber-Colman temperature controls chosen by leading makers of ground support equipment



Solar T-41M-9, top left
American Air Filter Co.—Defense Products Division C-10, top right
C. G. Hokanson Company—Model 798, left

Today's air and space vehicles call for a growing array of ground support equipment. Shown above are a few examples of support units employing Barber-Colman temperature control systems. Components used include: control boxes, actuators, valves, temperature sensing elements, and thermostats. The systems are specifically engineered for each application through the teamwork of the ground cart manufacturer and Barber-Colman.

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KNOW YOUR ALLOY STEELS . . .

This is one of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many who may find it useful to review fundamentals from time to time.

Steel

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Flame-Hardening Alloy Steels

The process known as flame-hardening involves the direct application of flame to the surface of steel, heating it above the transformation range, then hardening it by quenching. The primary purpose of this process is to achieve surface-hardness without affecting core properties. Jets of flame are played directly on the steel, and hardness penetration can be made to vary considerably. In alloy steels this depth will range usually from 0.03 to 0.12 in., the actual figure depending upon the method of heating and quenching used.

Unlike carburizing, flame-hardening does not involve the absorption of extraneous elements by the steel. There is no alteration of the chemical composition. To put it simply, the steel must have its own self-hardening characteristics; it cannot be dependent upon carbonaceous salt baths, gases, and other media.

Flame-hardening is not a substitute for the conventional furnace method. Each has its uses. The particular virtue of flame-hardening is that the flames can be directed to localized areas. The furnace, on the other hand, is generally more economical and feasible when parts produced in large quantities must be hardened all over.

Any type of hardenable steel, alloy or carbon, can be flame-hardened, and there will usually be no scale or pitting. The alloy content is the governing factor when determining the quench. In some cases a rapid quench is required; in others, it can be as slow as air-cooling. Tempering presents no problems, for flame-hardened steel can be tempered as if hardened to the same degree by other methods.

A list of typical flame-hardened parts includes such familiar items as gear and sprocket teeth, and certain types of cams and rollers, and shoe treads. A complete list would include many other parts that often require a localized hardening treatment, especially for wear-resistance.

When you need information about flame-hardening methods, please feel free to consult with our technical staff. Bethlehem metallurgists will work with you, at no obligation, and you can depend on their suggestions. You can rely on Bethlehem, too, as a source of alloy steels . . . for Bethlehem makes the complete range of AISI standard grades, as well as special-analysis steels, and all carbon grades.

This series of alloy steel advertisements is now available as a compact booklet, "Quick Facts about Alloy Steels." If you would like a free copy, please address your request to Publications Department, Bethlehem Steel Company, Bethlehem, Pa.

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after the main landing gear wheels struck a snow bank during takeoff. A portion of the lower cap of the rib at station 83, which remained attached to one piece of lower cover by Huck bolts at the plank 1-2 and 3-4 splices, had all rivets sheared in a random pattern at five of the six "H" clips between the above-mentioned points. On this piece of rib cap there were abrasions due to rubbing of separated diagonals against the cap and of one rib tab on the mating "H" clip.

In this area of the wing most attachments of rib caps to diagonals and to the wing cover failed. Both the random pattern of the failures and the abrasions on mating parts are indicative of dynamic conditions with high and changing stresses in the wing covers during and after the rib failures. This random pattern of rib and rib attachment failures in the No. 3 tank area is entirely inconsistent with known failures produced by overpressurization of an Electra fuel tank.

Study of the damage to the left outboard engine support structure and nacelle disclosed that the lower right longeron fitting aft of the firewall failed in a clean tension break. After this the front end of the engine support moved upward and to the left with progression of damage until separation from the airplane occurred. Laboratory examinations of the Lord mounts which support the propeller reduction gear box disclosed evidence of repeated bottoming due to abnormal loading in various directions.

Numerous curvilinear scratches, approximately partial ellipses, on the outer surface of the swirl straightener extension and severely scratched areas on the inner surface of the tail pipe bell mouth indicate repeated interference due to large cyclic motions of the engine relative to the wing prior to gross over-all displacement of the engine support structure from its normal position. Initial failure of the right outboard engine support structure consisted of a tension separation of the upper left longeron from the attach fitting at the firewall. The front end of the engine support then moved downward and to the right and rotated with the propeller with progression of damage until separation from the wing occurred. In the process of destruction the right lower longeron tore off the rear attach fitting with repeated interference between the longeron and fitting. The Lord mounts which support the propeller reduction gear box also were damaged due to abnormal loading in various directions.

LABORATORY TESTS

Numerous fractured fittings and parts of the left and right outboard engine support and nacelle structures were subjected to laboratory examinations. These examinations disclosed no evidence of fatigue cracking, nonconforming material, overtorquing of nuts, or missing attachments. All efforts failed to disclose positive evidence identifying any of the noted damage to the outboard engine support and nacelle structures as having existed prior to the last flight.

All recovered wreckage was examined for evidence of fire having caused the disintegration in flight. Only one probable area of fire prior to the right wing separation was found. This was in the aft part of the right outboard nacelle and the portion of the flap aft thereof and was only of sufficient duration to melt thin aluminum alloy sheet prior to impact with the ground. It produced no weakening of the structure in the areas where the inflight separations of the right wing and outboard engine support structure occurred.

This accident was characterized by separation in the air of portions of Nos. 1 and 4 powerplants as well as the right wing. Major powerplant components were found along the wreckage path in the following order:

- **No. 4 propeller**, reduction gear assembly, and torquemeter.
- **No. 1 propeller** and major portion of the reduction gear assembly.
- **No. 4 power section.**
- **No. 3 powerplant** in its entirety with the right wing.
- **No. 1 power section**, torquemeter and a portion of the reduction gear assembly.
- **No. 2 powerplant** in crater at the fuselage site.

All components lay at the location at which they first contacted the ground except for a minor displacement downslope of the No. 1 power section.

There was no fire damage on any of the powerplants. The blades of all propellers, except those of No. 2, were found in their entirety with or in the immediate vicinity of their respective hubs. The No. 2 propeller, along with the remainder of the powerplant, was dug from the fuselage crater site and only identifiable portions of all blades were recovered.

CONTROL SYSTEMS

Powerplant control systems were damaged by separation and impact so that they revealed no reliable information with respect to power configuration at any time prior to impact.

Examination of the engines and propellers for operational failure included:

- **Oil systems for significant** contamination.
- **Propeller reduction gear** and accessory drive systems for gear and/or bearing failure.
- **Torquemeters for rotational** interference.
- **Power section rotors** for overtemperature, bearing distress, or rotor failures.
- **Safety couplings for typical** operational decoupling markings.
- **Fuel pumps and fuel controls** for significant contamination or evidence of malfunction or failure.
- **Propeller pitch-change** mechanisms for significant contamination or evidence of malfunction or failure.
- **Propellers and engines** for evidence of overspeeds.

This examination was negative with respect to evidence of operational failures. Examination of the Nos. 1 and 4 powerplants showed that the struts remained with the power section of both engines. The torquemeters remained with the No. 1 engine power section and with the No. 4 propeller reduction gear assembly. Separation of No. 1 engine occurred through the reduction gear case at approximately the diaphragm split line. Stud failures that occurred at separation were necked down and bent in a pattern showing counterclockwise rotation of the forward part as separation occurred. The separation fractures of Nos. 1 and 4 engines did not show evidence of fatigue or post separation markings which indicated load reversals.

The inner surface of the air inlet housings and compressor cases of Nos. 1, and 4

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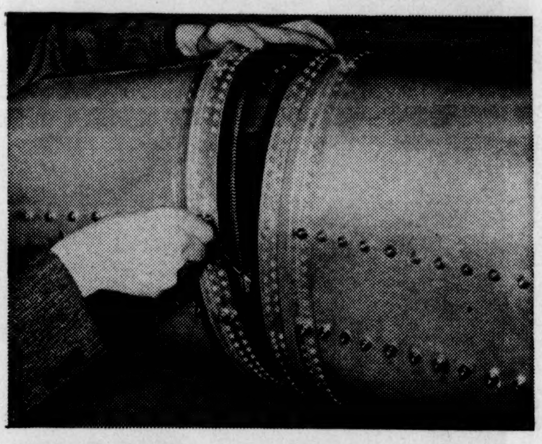

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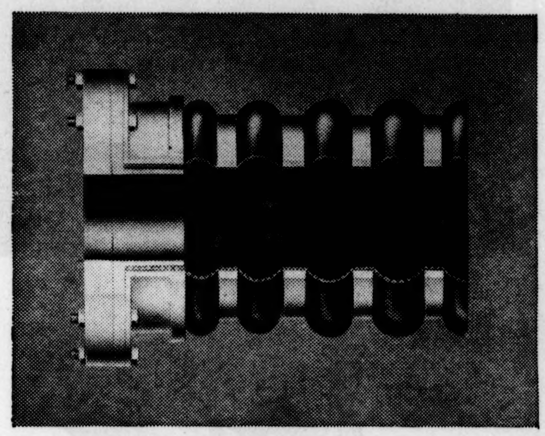

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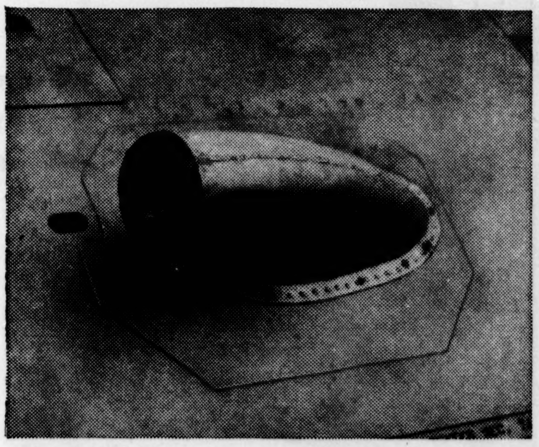

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engines were rubbed by the compressor blades. There were aluminum deposits on the thermocouples and turbine nozzles of the same engines. The high speed pinion of No. 1 engine remained with the torquemeter assembly. Spiral marks were evident on the drive side of the pinion gear teeth. Separation of the rotating parts of No. 4 engine occurred at the forward end of the compressor extension shaft where it engages the torquemeter shaft. Spiral marks were made after disconnect showing the power section end was rotating faster than the torquemeter end. Ends of some of the splines of the extension shaft were upset rearward; also, light axial scrape marks from front to rear showed on some of the extension shaft splines.

AIRCRAFT SYSTEMS

Damage to the aircraft was so extensive that no aircraft system, as such, remained intact. Systems components received light to extreme impact damage and in many cases fire damage was evident. The following are the salient facts disclosed by examination of the recovered components:

Many items of the hydraulic system were badly damaged by impact forces and in some cases fire had been present. Damage to valves and pumps precluded operational checks of such units. No operational damage was noted on any units. Hydraulic system items associated with the right main gear remained intact on the gear but were for the most part covered with a moderate coating of smoke deposit. The right fluid heat exchanger was recovered separately with only a small dent in the housing, and undamaged by fire. Both service center packages received moderate impact and fire damage.

Most of the recovered parts of the control surface boosters received severe impact damage. Based on the position of shutoff and bypass valves, the aileron and elevator boosters were in the "ON" position and the rudder was almost completely in the "Manual" position. However, all cables to the controls were broken and the inflight positions of these valves may have been altered at impact.

Loss of electrical or hydraulic power permits the autopilot engaging valve to move to the disengaged position. This was the position of the elevator and rudder valves; however, the solenoid core of the aileron valve was found trapped in the body in the "ON" position, the probable result of impact forces.

The four check valves of each hydraulic manifold were tested. All except three from the aileron manifold passed the test. These three permitted a very slight internal leakage in the closed position and signs of operational distress were noted during their inspection.

The load control units and sensors were considerably damaged. The only operable parts were the pistons that actuate the sensors. The main spool control valves were distorted but were properly assembled.

One of the two retaining pins of the divider section of the rudder cylinder was missing. There was no indication of flaring on the remaining pin. The hole showed no sign of scoring nor was the barrel damaged in the immediate area of the hole. Nothing was observed during the examination to suggest booster malfunction prior to the accident.

Because of extensive damage, examination of the electrical system yielded little information. There was indication of rotation of the No. 2 a.c. generator at the time of impact and no indication of rotation for those on engines Nos. 1, 3, and 4. Impact marks on the inverter indicate that it was not operating at the time of impact. There was no indication of electrical fire or overload on any of the units or wire bundles.

The radio equipment was completely demolished by impact; there were no indications of electrical overload or burning of any of these units. Examination of the badly damaged components of the various instruments and the autopilot yielded no useful information.

Impact damage prevented testing of fueling valves No. 1, No. 2, and No. 3. Fire damage to seals, switches, etc., prevented the testing of valve No. 4. Disassembly of these valves showed no signs of operational distress or abnormal wear. All four dump valves were in the closed position. The right dump check and swivel valve was relatively undamaged and closed. The left assembly received severe impact damage and was partially open.

The relief valves of the vent valves were bench checked. Although the valves from No. 1 and No. 3 tanks had been burned and were sticking on the first test, all four valves consistently opened at the specified pressure on repeated tests.

Only the right wing fuel shutoff valves were recovered. The No. 3 was approximately 25% open and the No. 4 was open. The No. 2 emergency shutoff was not identified among the recovered items. The No. 1 was one-half open, the No. 3 was approximately 5% open, and No. 4 was closed.

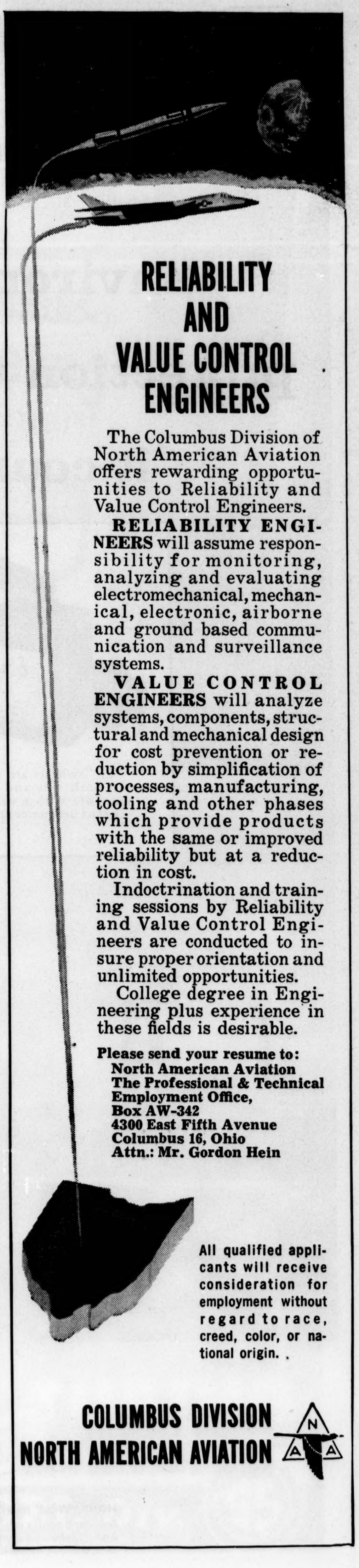
All crossfeed valves were accounted for. The No. 1, No. 3, and No. 4 were closed. The No. 2 and the left-to-right wing valves were approximately one-third open.

The engine-driven compressor from the No. 3 engine was intact. It had been damaged by impact and was unburned. The compressor from the No. 2 engine was demolished by impact but was unburned. Examination of oxygen and air-start system items disclosed no significant information.

Inspection of the anti-icing system ducting disclosed no evidence of internal duct fire. The two fire extinguisher containers of the No. 2 nacelle were destroyed by impact. One of the discharge heads was recovered. It had not been fired. Both containers from the No. 3 nacelle were recovered intact and fully charged. One portable CO_2 cylinder, identified as being from the flight station, was damaged by impact. Its handle and discharge horn were missing but it still retained a charge.

MAINTENANCE RECORDS

Review of the maintenance records of N 121US disclosed only one item that appeared of possible significance to the accident investigation. This pertained to a refueling incident in which No. 3 fuel tank developed a leak at a nacelle wing fairing attachment crew location. The leak was attributed by Northwest Airlines' personnel to rupture of the tank sealant by an excessively long screw. Although subsequent investigation disclosed that the tank had



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been overfilled, detailed study of the right wing wreckage, as previously mentioned, disclosed no structural damage or deformations due to over pressurization of the tank.

A review of all other Northwest Airlines records pertinent to the airworthiness of this airplane disclosed nothing of significance.

(This is the first half of the CAB report on the crash of a Northwest Airlines Electra turboprop transport on Mar. 17, 1960. The concluding portion of the CAB report will appear in a subsequent issue of AVIATION WEEK.*)*

Convair 880 to Test Runway Slush Effects

Washington – Federal Aviation Agency plans to measure the effect of slush on jet transport takeoff performance by accelerating a Convair 880 almost to lift-off speed on a runway coated with melting ice or a substance that simulates its drag.

Scheduled for this summer at either Dulles International Airport here or at FAA's Atlantic City, N. J. experimental center, the test program is expected to furnish background data for an agency rule on slush accountability.

Weight penalties to be imposed on jet transports taking off from slush-covered runways and responsibility for measuring slush depth were subjects at issue when FAA officials met recently to discuss their rule proposal with representatives of the U. S. Weather Bureau, airport managers and the airline industry.

All parties at the two-day conference disclaimed responsibility for measuring the volume of slush on any given runway at any given time (AW Apr. 10, p. 51).

However, a suggestion that the job be given to joint airline "snow committees," which expedite the flow of traffic at major terminals during bad winter weather, encountered little opposition at the meeting.

On the specific question of slush measurement, the Weather Bureau pointed out that its attempts to measure snow and ice were often in error by as much as 50%.

However, the over-all effect of slush accumulation is being determined by some European carriers by dragging an instrumented wheel down a runway, then extrapolating the resistance as measured.

FAA admits that "very little is known" on the effect of slush on the braking capacity of wheels and hence on accelerate-stop distances in standing water, wet snow and melting ice. The agency feels, however, that National Aeronautics and Space Administration tests provide enough data for an "interim regulation" on jet transport takeoff accountability in slush.

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Death Struggle

Much as we all may enjoy it—instead of spending too much valuable time debating the pros and cons of aviation and space politics, government spending policies, and how or why we might get humanity into orbit—let's face a few simple facts.

We, as citizens of countries of the free world, are in a struggle to the death with international communism; an ideological and material war which will be won by the side who gets there "firstest with the mostest."

Let's take advantage of what we now have to work with, bend our backs, roll up our sleeves, and go to work. No battle was won on paper, whether front page or last.

George W. Stetson, III
Woburn, Mass.

Traffic Control System

From an impartial viewpoint it is gratifying to read in your June 5 issue (p. 93) of the planned scientific evaluation by the Federal Aviation Agency of the Air Force's AN/GSN 11 semiautomatic traffic control system. Confidence in the scientific approach led to the formulation of the Airways Modernization Board and its successor, FAA's Bureau of Research and Development with its extensive test facilities at the National Aviation Facilities Experimental Center, Atlantic City, N. J. The foresight used in providing this capability should pay off handsomely in the immediate future when competing, complex and expensive systems will be proposed to meet the rapidly increasing demands of air traffic.

Faced with pressing airspace demands, a finite budget, time constraints on decision-making caused by long-lead-time requirements, and the cost of making wrong decisions, the FAA must take full advantage of the established scientific capability in steering its program toward objective ends.

The evaluation of GSN-11 and the determination of its future role in the desired FAA program provides an excellent opportunity to exploit the developed scientific capability in producing a factual effectiveness study. This would go far toward establishing confidence in the FAA program with equipment proposers, users and Congress.

The study can be made in such a manner as to establish irrefutable findings or, at least, to provide the basis for factual disagreement. It is hoped that it will include:

(a) The definition of measures of effectiveness in which the desirability of the system can be quantitatively expressed. These measures must adequately reflect the over-all objectives of the Agency.

(b) Analysis and simulation techniques which realistically represent the Air Traffic Control System and the environments in which it operates. These methods should partition the problem in such a way that interactions between en route and terminal areas are not significant.

(c) An adequate error analysis to determine the mean and distribution of errors introduced by pilots, controllers and environmental conditions. This analysis can be supported by the flight and position measuring facilities at NAFEC and by human engineering studies.

(d) A realistic cost study in which initial and operating costs are accurately estimated and the amount and beneficiaries of cost savings determined.

(e) A reliability study to determine the influence on system effectiveness of those safety measures which must be incorporated to allow for equipment and human malfunction.

R. G. Tuttle,
Bethesda, Md.

Jet Fuel Tanks

The current controversy over the relative hazards of using JP.4 (aviation turbine gasoline) or JP.1 (kerosene) as fuel for turbine engined and jet aircraft is as yet unresolved. However, both protagonists are agreed that the overriding factor from all points of view is maximum passenger safety.

By their very nature all fuels are dangerous when not contained, and in this respect it is interesting to note that the Recommendations Appendix to Chapter D5-2 of British Civil Airworthiness Requirements Section D states: "When possible fuel tanks should not be located within the fuselage or the center section of a wing passing through the fuselage." Also, "where tanks must be installed in locations likely to be distorted inboard of, or adjacent to, the outboard engine, robust bag type tanks protected against local damage are recommended."

It could well be that the torsion box integral fuel tank of shear web/integrally machined skin/stringer panel construction is not so "likely to be distorted," but the fact remains that bag type tanks do have a greater margin of safety at crash case and emergency landing case inertias. This fact is well illustrated by an analysis of results of accidents to aircraft fitted with even lightweight bag tanks.

Turbine aircraft of relatively high wing loading have large fuel capacity demands, and the fitting of bag type tanks will reduce the capacity compared with integral tanks. Also, bag tanks incur a weight penalty with a consequent reduction in payload. However, their use considerably simplifies the surrounding structure and in the event of local damage to a bag tank it can be quickly and easily repaired or replaced. The weight penalty incurred would represent only a marginal increase in cost per passenger mile which is out of all proportion to the increase in safety which would be achieved.

The general introduction of bag tanks—particularly in the danger areas inboard of the outboard engines—is long overdue and would allow airline operators to choose either JP.4, kerosene or any other fuel based on their relative technical and economic merits. These facts should be brought to the notice of the public, who rightly expect to travel as airline passengers with maximum possible safety.

H. G. Muff
2, Blackdown Close,
Pyrford,
Woking
Surrey.

F-105D Systems

Aviation Week, usually accurate in most details, errs in its May 22, 1961 issue when it refers (p. 74) to the F-105D's ". . . necessarily complex R.14 all-weather navigation and fire control system developed by North American Aviation's Autonetics Division." Development of the navigation and fire control systems for the F-105D was the responsibility of Republic Aviation Corporation, the weapon system manager. In the development of the AN/ASG-19 or Thunderstick Fire Control System for the F-105D, General Electric's Armament and Control Section, Light Military Electronics Department, played no small part.

The Autonetics R.14 (NASSAR) radar is used in the F-105D to provide navigation and fire control data to system components developed by a number of suppliers. A large portion of the Thunderstick Fire Control equipment, such as, the bombing, missile, and gun-rocket computers, a sight and attack display, and tie-in equipment were developed and manufactured by General Electric's Armament and Control Section, along with the FC-5 flight control system, and the fire and flight control ground support equipment. The flight control system operates as a part of the Thunderstick Fire Control System in some modes of operation.

Much of the work in fire control analysis and synthesis was performed by Armament and Control engineers, to whom Republic in its role as system manager relayed the specifications for fire control inputs available from equipment made by Autonetics, Lear, and Eclipse-Pioneer. Armament and Control conducted extensive and complex simulations of the F-105D in its various fire control modes of operation and performed the detailed analyses of data taken in flight test operation.

Because of its major contributions to the development and production of the F-105D's high performance, all-weather navigation and fire control system, General Electric's Armament and Control Section can take considerable satisfaction in the progress of the F-105D into "front-line operational positions." But the credit for the development of the avionics system must be accorded to Republic, the weapon system manager, and not with any of the several contributors to the joint development effort conducted by Republic.

B. E. Frisch
Manager, F-105 Marketing Program
GE Armament & Control Section
Johnson City, N. Y.